Technical Notes No. 1

NORTHEASTERN FOREST EXPERIMENT STATION
U. S. Forest Service
Amherst, Mass.

May 8, 1929.

Girdling Hardwoods to Release Spruce and Balsam Fir

By
M. Westveld

Girdling hardwoods in order to release and increase the growth of the young understory of pulpwood species has received considerable attention in recent years. In 1905 the Forest Service established a series of three plots at Corbin Park, New Hampshire, in a stand of northern hardwoods containing an understory of spruce from 2 to 6 feet in height. Heavy girdling and removal of hardwoods was practiced on one plot and only moderate girdling and removal on the second, while the third was left undisturbed to serve as a check plot.

Measurement of the plots at 5-year intervals following girdling showed a much more rapid gain in volume on the girdled than on the untreated plot. At the end of a 22-year period the heavily girdled plot showed on an acre basis a total volume, although not yet of merchantable size, of 902 cubic feet or approximately 10 cords; the moderately girdled plot 565 cubic feet, or 6.3 cords; the ungirdled plot 158 cubic feet, or 1.7 cords. In other words, growth on the heavily girdled plot was over five times, and on the moderately girdled plot three times as rapid as on the ungirdled plot.

Periodic annual growth on the heavily girdled plot increased from 1/4 cord during the period 1905 to 1920 to one cord per acre per year for the period 1925 to 1927; during the same period growth on the moderately girdled plot rose from 1/6 to 1/2 cord per acre per year. The ungirdled plot today is producing less than 1/10 cord per acre per year.

Expressed in dollars and cents on an acre basis the heavily girdled plot at $4.00 per cord stumpage at the end of the 22-year period produced $40 worth of spruce wood; the moderately girdled $25.20 and the control plot $6.80. The invested charge in girdling at the end of this period at 5% compound interest amounts to $6.14 for the heavily girdled plot, and $4.50 for the moderately girdled plot.

The experiment also shows that under the conditions represented by the experiment it is possible through girdling to convert a young merchantable hardwood stand containing an understory of spruce into a pure coniferous stand. It appears that pulpwood operators can more cheaply increase their pulpwood supplies by increasing their yields through girdling than through the purchase of more pulpwood lands.

Technical Notes No. 2

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NORTHEASTERN FOREST EXPERIMENT STATION
U. S. Forest Service
Amherst, Mass.

July 6, 1929

The Causes and Cost of Forest Fires in Central Massachusetts[1]

By
Paul W. Stickel

An analysis of the central Massachusetts forest fire records for 1926 to 1928 showed that annually 13,026 acres were burned over. The total land area involved is 2,521,056 acres which includes all of Worcester County, the eastern halves of Franklin, Hampshire, and Hampden Counties, the western half of Middlesex County, and one town in Norfolk County. Of the total land area, 1,258,449 acres (50 per cent) is classed as forest land being covered chiefly with a growth of northern white pine and eastern hemlock in various mixtures with hardwood species.

The average annual number of fires was 814, all of which were man caused. But one fire during the three years was attributed to lightning. Listed in their order of magnitude the four principal causes of fire were unknown, smokers, railroads and brush-burning. These four causes accounted for 668 fires each year or 84 per cent of the total number. In spite of the fact that there is a brush-burning permit law in the state, 108 fires annually (16 per cent) were caused by this factor. As nearly as could be ascertained from the original fire reports, 102 fires each year (12 per cent) were the result of people burning brush without a permit, while 55 fires each year (3 per cent) were caused by brush-burning permittees.

During the months of March, April, and May the fire hazard was most acute in the region under consideration. Especially prevalent were fires during the two last mentioned months - April and May. Annually during these two months together 662 fires occurred (81 per cent), burned over 12,116 acres (93 per cent), caused $96,124 (95 per cent) damage, and cost $19,048 to suppress (91 per cent). Two chief factors contributing to the extreme hazard during these early spring months are the hardwood foliage and the weather. Between late winter and late spring there is an interval during which time the hardwood leaves are either lacking or incompletely developed. Such a condition leaves the forest floor with its dead plant remains fully exposed to the drying-out action of sunlight, high air temperatures, high winds, and low relative humidities.

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[1] The writer wishes to express his gratitude to the Division of Forestry, Massachusetts Department of Conservation, for the loan of the state forest fire records and for furnishing the data on the forest area of Massachusetts.

The total annual damage caused by forest fires in the region was $101,229, with a total suppression cost of $20,866; 10,596 men working 35,568 man-hours were used in suppressing the fires each year. A cost analysis of the fires showed that the average sized fire per year was 16 acres, with damage of $124. In suppressing the average sized fire 13 men worked 44 man-hours necessitating an expenditure of $26 for wages, transportation costs, etc. The greater number of fires each year were five acres or less in size (619 fires or 76 per cent) which, however, burned over only 1,097 acres (9 per cent) and caused $9,143 damages (9 per cent) annually. While the annual area burned and damages were small for these small fires, their cost of suppression, number of men used, and man-hours worked were very much out of proportion compared to the same items for larger fires. Thus, each year 20 per cent of the suppression costs, 37 per cent of the number of men used, and 20 per cent of man-hours worked were expended in fighting fires in the 1 to 5 acre class. For fires 76-100 acres in size - whose average area burned by per cent was practically the same as for the 1-5 acre class, and yet whose average size per fire was almost fifty times as great - the annual percentages were as follows: suppression costs 5 per cent, number of men used 4 per cent, and man-hours worked 7 per cent. These data may be interpreted in one of two ways. First, that the forest fire wardens failed to secure sufficient men when fighting the larger fires and thereby did not prevent these from increasing still further in area. Or secondly, that the wardens called out more men than necessary when suppressing the small fires but thereby kept the small fires from becoming greater.

The direct economic loss to property caused by forest fires is recognized and appreciated by the general public. As far as is known, no one hithertofore has pointed out the indirect economic loss in man power. Thus, the annual number of man-hours used to suppress forest fires in central Massachusetts was 35,568. Converted into man-years, this means that annually a total of 16 man-years was lost to the community as the direct result of human carelessness.

Amherst, Massachusetts
June 25, 1929

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Technical Notes No. 3.

NORTHEASTERN FOREST EXPERIMENT STATION

U. S. FOREST SERVICE
Amherst, Mass.

February 5, 1930

Artificial vs. Natural Replacement on Blight-killed Chestnut Land.

by

Paul W. Stickel.

Since 1924 a series of three permanent sample plots have been maintained* on typical blight-killed chestnut land on the Mount Toby Demonstration Forest, Sunderland, Massachusetts. Two plots are located in a northern white pine plantation which was established when the dead chestnut was removed in 1919. A third plot is situated in a stand in which the blight-killed chestnut trees have not been removed. On one of the two artificial replacement plots, the competing hardwood sprouts - including chestnut - have been cut back annually so as to release the pines. All plots have been remeasured annually since their establishment.

The 1929 measurements showed that the basal area of the artificial plots is rapidly approaching that of the natural replacement plot. For Plot I (pine plot weeded) the basal area per acre was 15.9 square feet; for Plot II (unweeded pine plot), 11.3 square feet per acre; and for Plot III (natural replacement plot), 16.2 square feet per acre. The figures for the first two plots include only the basal area of conifers; for the last plot all species are included. Moreover, in the case of the artificial replacement plots the stands are composed entirely of one valuable species - northern white pine. On the natural replacement plot in contrast, less than 50 per cent of the stand has any commercial value. In less than a decade, therefore, artificial replacement using northern white pine stock has been successful.

The pines on the replacement plot where competing hardwood sprouts have been removed annually are making better growth than those on the check plot. On the weeded plot the trees in 1929 had an average diameter of 1.8 inches; an average total height of 11.7 feet; and approximately 70 per cent were in the dominant and codominant classes. On the unweeded plot similar measurements of the same year were: average diameter, 1.6 inches; average total height, 11.3 feet; and only 50 per cent were in the dominant and codominant classes. The weedings have kept down the height of the hardwood sprouts so that now the trees on the weeded plot overtop the hardwood canopy by almost three feet; on the check plot the conifers are overtopped by the sprout growth by three feet.

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* In cooperation with the Forestry Department, Massachusetts Agricultural College.

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Thus, while weeding of hardwood growth in pine plantations on cut-over chestnut lands is not absolutely necessary, it aids materially in the best development of the planted stock. Where such weedings are undertaken it is recommended that the first one be of a "broadcast" nature (all sprouts on the area cut back) and that subsequent weedings be confined to releasing individual pines. In the above study, the "broadcast" weeding of 1925 required 32 man-hours per acre; clump weedings since that date required 6 to 8 man-hours per acre.

Amherst, Massachusetts.
February 4, 1930.

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NORTHEASTERN FOREST EXPERIMENT STATION
U. S. Forest Service
Amherst, Mass.

Factors Influencing Decay of Hardwood Slash in Northern New England and their Relation to the Practice of Lopping

by
Perley Spaulding
(Forest Pathologist, Bureau of Plant Industry, Amherst)

A study of the decay of hardwood slash in northern New England as influenced by lopping, shows that there are certain factors governing the rate of decay. The more important of these factors are: The species of tree furnishing the slash, the rate of growth of the tree, the direction of slope where the slash lies, and the moisture of the soil.

Different species of wood vary greatly in their resistance to decay. The species studied are ranked according to relative durability of the slash as follows, beginning with the least resistant: Aspen, poplar, paper birch, basswood, beech, maple, yellow birch, ash, oak, chestnut.

The rate of growth of the tree controls the relative amount of sapwood and heartwood to a marked degree. Sapwood usually rots more quickly than heartwood, but in some species there is little difference. Aspen, poplar, and basswood show little differentiation between sapwood and heartwood, and there is also little difference in rate of decay. Paper birch, beech, maple, and yellow birch show a decided difference in rate of decay of sap- and heartwood, while the most pronounced differences are shown by ash, oak, and chestnut.

Direction of slope is a more important factor than has been realized. On warm slopes the slash may season quickly, become case-hardened, and resist decay for many years. On cold slopes the slash may become waterlogged before decay begins, and also resist decay for a long time. Both conditions result in retarding decay to an undesirable degree. The moisture in the soil also has a very marked influence on these two undesirable conditions of the slash. The species of slash have been ranked in their readiness to become waterlogged, grading from those easily saturated to those most resistant as follows: Yellow birch, beech, basswood, maple, poplar, oak, chestnut, ash. Soil suitable for corn or potato production has about the optimum amount of moisture for the decay of slash.

It has been concluded that lopping will not pay with aspen, poplar, or paper birch, because they rot quickly, and lopping cannot hasten decay appreciably. Lopping is also liable to bring on waterlogging of these species. Beech, maple, and basswood waterlog easily enough so that in most situations lopping is of questionable value, as it places the slash in the most favorable position to absorb water from the soil. Yellow birch slash seems to be especially prone to waterlog, and it should rarely be lopped. On the other hand, a few species, such as ash, chestnut, and oak, resist waterlogging to such a degree that lopping should hasten decay decidedly.

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February 14, 1930

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Technical Note No. 5 March 15, 1930.

UNITED STATES DEPARTMENT OF AGRICULTURE - FOREST SERVICE
NORTHEASTERN FOREST EXPERIMENT STATION*

Slash Conditions on Cutover Spruce-Hardwood Lands in the Northeast

by

M. Westveld

Lumbering operations in the mixed spruce and hardwood stands of the Northeast leave as much as 39 percent of the ground covered with limbs, tops of trees, and brush cut during the logging job. Nearly half of this debris or slash is of such density as to preclude the establishment of new seedlings for many years. Softwood slash is much more damaging in this respect than hardwood slash, owing to the tendency of the former to form more compact masses.

Dense softwood slash not only crushes and kills advance reproduction beneath it, but effectually prevents the establishment of new reproduction for a period of from 15 to 20 years, while hardwood slash rarely hinders reproduction for more than six years. This emphasizes the need of burning dense softwood slash in order to make possible the early reclamation of these slash-covered areas for renewed timber production. Although severing the limbs and branches of the tree tops to bring the debris in contact with the ground (termed "lopping") usually hastens decay, it tends to still further compact the mass and increases the chances for smothering seedlings. Unlopped tops, particularly hardwoods, permit a certain number of seedlings to push their way through without undue interference.

A study, being made by the Northeastern Forest Experiment Station on areas from which an average of 8,750 board feet of hardwoods and softwoods were removed, shows that 18 percent of each acre is covered with dense slash, 11 percent with medium, and 10 percent with light; a total of 39 percent. Calculated on the basis of equal volumes of hardwoods and softwoods removed, softwood slash covers only 67 percent as much area as hardwood slash. However, although hardwood slash tends to occupy a greater surface area per unit of volume removed, much of it is of medium or light density. In these tests only 36 percent of hardwood slash was classed as dense as against 62 percent for softwood.

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* In cooperation with Massachusetts Agricultural College, Amherst, Mass.

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Technical Note No. 6 March 15, 1930

UNITED STATES DEPARTMENT OF AGRICULTURE - FOREST SERVICE
NORTHEASTERN FOREST EXPERIMENT STATION*

Solar Radiation and Forest Fire Hazard

by
Paul W. Stickel

Patrolmen, forest fire wardens, and others concerned with forest fire protection should develop a cloud "weather eye". Investigators in forest fire weather research have long felt that there is a high correlation between the amount of sunshine and forest fire hazard, and the hypothesis is amply substantiated by recently published results of experiments in white pine debris, or "duff", at the Harvard Forest, Petersham, Massachusetts.

By using cloth screens of varying thickness, artificial degrees of "cloudiness" were produced on the forest floor, ranging from 50 to 30 per cent of full sunlight. In addition, one area was completely exposed. Duff hygrometers and sets of thermopiles in conjunction with a recording galvanometer were used to measure the duff moisture and solar radiation; while relative humidity was measured with a sling psychrometer. During the 60 days covered by the experiments, the fully-exposed duff was consistently drier than that of the protected plots. Likewise, the likelihood of fire spreading was lowest on the "cloudiest" area. In other words, any diminution in intensity of daylight reduced the rate of drying of the duff and retarded the development of acute fire danger.

The variations of the daily trends of radiation intensity could be divided into three groups: days with radiation intensities greatest around midday; days with radiation intensities diminishing from an early morning high; and days with radiation intensities increasing throughout the day. The curves of duff moisture contents followed closely the trends of solar radiation intensities within these three groups.

A study of records covering 313 three-hour periods showed that the lower the relative humidity the greater the radiation intensity. The coefficient of correlation between these two factors ranged from -0.75 to -0.89. Thus relative humidity is of value as an indicator of forest fire hazard not only because it expresses the moisture deficit of the air, but also because it gives some approximation of solar radiation intensity.

These relationships are of importance in the prediction of the probable spread of forest fires. By estimating the ordinary fire hazard for any locality and summarizing the average cloudiness since the last rainfall, a better estimate of the condition at any given time is possible. Lastly, these studies indicate the role played by the ground vegetation in reducing fire danger and the importance of getting cut-over areas clothed with some growth as quickly as possible.

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* In cooperation with the Massachusetts Agricultural College, Amherst, Mass.

Gast, P. R. and Stickel, P. W. Solar radiation and relative humidity in relation to duff moisture and forest fire hazard. Mon. Wea. Rev. 57:11, 466-468. Nov. 1929.

Gast, P. R. A correlation between solar radiation intensities and relative humidities. Mon. Wea. Rev. 57:11, 464-465, Nov. 1929.

INTERMOUNTAIN STATION
Central Reference File
No. 0.73

Technical Note No. 7 April 1, 1930

UNITED STATES DEPARTMENT OF AGRICULTURE,
NORTHEASTERN FOREST EXPERIMENT STATION[1]

FOREST FIRE WEATHER DATA FOR THE HARDWOOD-SPRUCE FOREST TYPE

by

Paul W. Stickel

There is a high correlation between weather conditions and forest fire hazard. This is borne out by a preliminary analysis of the data obtained by a forest fire weather study carried on jointly by the New York State College of Forestry, Syracuse, New York, and the Northeastern Forest Experiment Station. The conclusions are based on a five-year investigation at the Charles Lathrop Pack Demonstration Forest, Cranberry Lake, New York, in the hardwood-spruce forest type.

The moisture content of the "duff" or top layer of the heavy litter found on the ground in the forest was used as the indicator of fire hazard. By making actual inflammability tests under various degrees of duff moisture content with the fire brands listed below, six zones of inflammability are recognized as follows:

Degree of Hazard and Duff Moisture Content	Dangerous Fire Brands
Extreme, below 6 percent	Cigarettes, locomotive sparks, pipe heels, matches, and camp fires.
High, 6 to 10 percent	Locomotive sparks, pipe heels, matches, and camp fires.
Medium, 11 to 16 percent	Pipe heels, matches, and camp fires.
Low, 17 to 22 percent	Matches and camp fires.
Very low, 23 to 29 percent	Duff at edges of camp fires will smolder but not spread much.
Generally safe, 30 percent and above.	None; generally safe from all.

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[1] Maintained in cooperation with Yale University, New Haven, Conn.

The relations between the more important weather factors and the inflammability zones of duff in the open and in the forest are illustrated in the following two tables:

Legend

A.T.	Air temperature, Degree F.
D.T.	Top duff temperature, Degree F.
E.V.	Evaporation per hour, cubic cent.
R.H.	Relative humidity, percent
P.	Depression of dew point, Degree F.
Hr.	Hours since last trace of rain.
M.	Hours since last measurable rainfall

In the open

Degree of hazard	A.T.	D.T.	E.V.	R.H.	P.	Hr.	M.
Generally safe	Below 68	Below 74	0-1.2	100-59	0-13	0-18	0-34
Slightly dangerous	68-74	74-82	1.3-1.7	58-45	14-20	19-35	35-62
Moderately dangerous	75-78	83-91	1.8-2.1	44-34	21-27		
Dangerous	79-82	92-102	2.2-2.6	33-23	28-39	36-77	63-122
Highly dangerous	83-85	103-120	2.7-3.4	22-15	40+		
Extremely dangerous	86+	121+	3.5+	14-		78+	123+

In the forest

Degree of hazard	A.T.	D.T.	E.V.	R.H.	P.	Hr.	M.
Generally safe	Below 84	Below 99	0-2.1	100-28	0-30	0-89	0-200
Slightly dangerous	84-87	99-111	2.1-2.4	27-19	31-41	90+	201-264
Moderately dangerous	88+	112+	2.5-2.8	18-	42+		
Dangerous			2.9-3.4				265+
Highly dangerous			3.5+				
Extremely dangerous							

In using the above data to estimate fire hazard, it is suggested that 2 p.m. meteorological observations be used, and that the various factors be used in conjunction with one another. In general, 2 p.m. meteorological observations are of greatest value since at that time daily maximums and minimums are usually secured. In making an estimation of the probable hazard, the first step should be to use the hours since trace or hours since last measurable rainfall factors. Then the current psychrometric determinations should be applied to such factors as air temperature, relative humidity, and depression of dew point. It is believed that these data are applicable to the hardwood-spruce forest type throughout northeastern United States and eastern Canada.

INTERMOUNTAIN STATION
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Technical Notes 8

No. 8

U. S. Department of Agriculture
NORTHEASTERN FOREST EXPERIMENT STATION*

Amherst, Mass. October 1, 1931

Releasing Merchantable Sized Spruce and Fir Through Girdling

by
M. Westveld

Additional data obtained from girdling experiments indicate that highest returns in dollars can be realized through girdling hardwoods which are suppressing pulpwood species already of merchantable size. This is obvious since the bulk of the increased growth resulting from reduced hardwood competition will be added to merchantable crop trees having marketable value.

Definite figures on increased growth on merchantable crop trees following girdling of hardwoods were obtained from a girdling experiment located in a typical mixed spruce and northern hardwoods stand on the holdings of the Eastern Manufacturing Company lands near Patten, Maine. Girdling of all hardwoods on the plot down to 2 inches d.b.h. in 1919 released 40 spruce and fir per acre with an average diameter of 8 inches and a volume of 272 cubic feet (2.8 cords). Eleven years later, instead of a yield of 412 cubic feet (4.3 cords) which it is calculated would have occurred in the absence of girdling, the plot showed 1050.4 cubic feet per acre (11.0 cords) of merchantable pulpwood, an increase directly attributable to girdling of 638.4 cubic feet (6.7 cords). Even during the first 4 years following girdling the increase over normal growth amounted to 115.2 cubic feet (1.2 cords). The number of merchantable trees during this period had increased to 160.

Periodic annual growth rose from 1/7 cords per acre per year to 3/4 cords which is a 5 fold increase in the growth rate. It is calculated that the increased growth resulting from girdling during the eleven year period netted a profit of $2.00 per acre per year.

The experiment shows that profits on girdling investments in stands containing crop trees of merchantable size can be realized in the relatively short period of 4 years. Moreover it appears that in such stands the added growth put on the first 2 years following girdling will more than pay for the girdling costs. Should fire or other damage make it necessary to salvage the crop within a few years after girdling, it would be possible to do so without loss of the initial girdling investment.

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*In cooperation with the Massachusetts State College, Amherst, Mass.

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Technical Notes No. 9

U. S. Department of Agriculture
NORTHEASTERN FOREST EXPERIMENT STATION*

Amherst, Mass. October 1, 1931

Organic Factors Involved in Decadence of Birch on Cut-over Lands in Northern New England

by
Perley Spaulding and H. J. MacAloney

In northern New England the cutting of merchantable timber from mixed stands often leaves a thin scattered stand of paper and yellow birch and other hardwoods. Within a few years after cutting, these residual birches decline and often die. This decadence has been attributed to the bronze birch borer, the shoestring fungus, and other causes. For several years investigations have been carried on to determine its cause. In 1930 the authors undertook to learn just what part the borer and the fungus actually play in the dying of such birches.

A study of the physiological factors involved has been made by Doctor R. C. Hall. In 1927 he began these studies in northern New England as an agent of the Bureau of Entomology cooperating with the Northeastern Forest Experiment Station. In 1929 he continued on a cooperative basis with the above organizations and the University of Michigan, working also in northern New England. In 1930 he continued the work in the Lake States, as an agent of the University of Michigan. His results will be published elsewhere.

The conclusions reached by the authors are as follows:

1. In the stands studied the bronze birch borer cannot be considered as a primary insect pest. There is ample evidence, however, that as decadence progresses the trees become more subject to attack and in many cases the borer is a contributing cause of death.

2. With our present knowledge, the decadence of birch could not be attributed to any fungus as a primary cause. Armillaria mellea undoubtedly helps to destroy trees previously injured by other factors.

3. The yellow birches studied had been suppressed under an over mature stand for a long time. The sudden excessive opening subjected them to extreme light and heat on the uppermost twigs which they could not survive. The condition of the roots would not indicate marked inability to supply water, but the decidedly changed water conditions of the soil may prevent their functioning to maximum capacity in dry times.

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4. The paper birch appears to have attained an age in these stands where it has lost its ability to sprout readily, and it was unable to come back after a long period of growth decline. Its incipient decadent condition was aggravated by the sudden release.

5. Remedy, so far as organic factors go, consists in preventing mechanical injuries, which largely furnish entry to the bronze birch borer and to Armillaria mellea.

6. It is suggested that in selective cutting only relatively young trees should be retained for future growth, especially in the case of paper birch; and that yellow birch stands can only be opened up gradually. Cutting to a diameter limit may not result in leaving trees which are young enough to profit by release, as they may be of slow growth and really older than suspected.

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Technical Notes No. 10

U. S. Department of Agriculture
NORTHEASTERN FOREST EXPERIMENT STATION*

Amherst, Mass. October 1, 1931

Suggestions for Estimating Cull in Northern Hardwoods

by

Perley Spaulding, G. H. Hepting, and M. Westveld

The following conclusions are based on studies conducted on the Gale River and Bartlett Experimental Forests in the White Mountains, supplemented by observations in sawmills and logging areas at Easton, N. H. and Wenlock, Vermont.

The Chief Fungi

Fomes igniarius: a large, brown to black, woody fungus, brown beneath, usually entering thru wounds. Fruiting bodies indicate serious loss extending 15 feet or more in all species. Cull heavily. Occurs on all hardwoods.

Fomes nigricans: usually sterile, clinker-like, black fungus causing open wounds with protruding, swollen edges on which the sterile, black masses form. On the birches. Cull as for *F. igniarius*.

Fomes connatus: a small, white, corky polypore usually with moss on the upper surface. Enters branch scars, bruises, or open seams. Rot extends up and down but one or two feet from the fruiting body. An average cull of 3 feet is sufficient. Occurs primarily on the maples.

Fomes applanatus: a large, flat, woody fungus with grayish upper surface and white lower surface which blackens when scratched. Quite common as a wound parasite. Rot generally extends 4 to 6 feet in each direction from the fruits.

General

Old logging scars, porcupine work, open seams, etc., if extending to the ground so as to be kept moist and open enough for ready entry of air, require a cull of 6 to 8 feet. If located 6 inches or more above the ground so as to remain dry, no cull is needed except for the mechanical injury.

If air cannot enter freely wet wounds often remain unrotted.

Butt rot starting at or below ground level is more serious than when starting above ground level.

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Amount of interior defect is proportional to the size of defective surface knots.

Churn buttedness in a tree is no sure indication of butt rot.

Hardwood timber growing in low, wet, places is apt to be pretty defective, while on well drained soils it generally runs fairly sound.

Hardwood stands from which spruce and fir have previously been cut run heavier to defect than stands from which the cutting of softwoods has been negligible.

Sugar Maple:

Cull lightly.

Chief rot is Fomes connatus, for which average cull of 3 linear feet is sufficient.

Fruiting bodies of Fomes igniarius indicate serious loss.

Decayed knots are less serious than in yellow birch.

Seams generally go deeper than in yellow birch and require a discount.

Open scars are often caused by maple borer injury. Such scars shoul be handled as follows:

(1) If the dead wood is kept moist by adhering dead bark, rot is apt to enter. Cull such cases several feet.

(2) If the dead wood of the scar is bare and new growth below the wound is cupped so as to hold water, cull 2 to 3 feet; if not cupped, cull only for mechanical injury.

Soft Maple:

Cull heavily.

Fomes connatus is frequent; cull 3 feet each way from fruiting body.

Fomes igniarius is common; cull very heavily as fruiting bodies mean complete loss in most cases.

Swollen knots and seams are apt to indicate black heart if not rot.

Yellow Birch:

Cull moderately.

Butt rots require average cull of 3 feet at the mill.

Fomes igniarius is common. Cull 50 - 100%

Open cankers with depressed center and swollen edges upon which irregular, black, clinker-like, rather brittle masses occur indicate heavy loss, i.e., 50 - 100%.

Decayed knots are more serious than in sugar maple.

Seams seldom require a discount unless they fold inward.

Paper Birch:

Cull moderately.

Fomes igniarius fruits mean nearly total loss. Open, depressed cankers with black center or edges mean heavy loss - cull 75% or more.

Beech:

Fomes igniarius is common and causes 50 - 100% loss. One fruiting body on lower trunk with large rotten knot or stub on upper trunk indicates total loss.

Fomes applanatus: cull 4 to 6 feet from the fruits.

Beech is extremely deceptive as rot starts and ends abruptly, except with Fomes igniarius.

In stands where Fomes igniarius is plentiful, stems with rough, swollen knots should be culled even though no conks are in evidence.

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Technical Notes No. 11

U. S. Department of Agriculture
NORTHEASTERN FOREST EXPERIMENT STATION*

Amherst, Mass. March 3, 1932

Investigations in Decays of Balsam Fir. I.
Gale River Experimental Forest, New Hampshire

by

Perley Spaulding[1], George H. Hepting[1], and H. J. MacAloney[2]

The Gale River Experimental Forest is an area of approximately 1300 acres lying about two miles southeast of Bethlehem, N. H. The balsam fir occurs in the spruce flat type over a considerable part of the eastern half of the area. It is nearly even aged, ranging from about 60 to 70 years old. It evidently came in following early lumbering operations and a subsequent clean burn. On most of the area red spruce is interspersed with the balsam fir abundantly enough to make a rather open stand if the balsam fir is entirely removed. Five 1/4 acre plots were selected, cut, and examined for decay by methods developed and applied in western species by Meinecke, Weir, and Boyce, and in balsam fir in Canada by McCallum. All balsam firs down to 1 inch D.B.H. were cut.

Three decays were found to cause most of the cull in this species. They are: red heart, caused by Stereum sanguinolentum (Alb. and Schw.) Fries and occurring in the middle or upper trunk, brown butt rot caused by Polyporus balsameus Pk., and stringy butt rot caused by Poria subacida Pk. The butt rots are serious because of their weakening action leading to windthrow. Examination showed that on the worst areas where windthrow is now going on, as high as 20 percent of the total stand of this species has been windthrown as a direct result of these butt rots weakening the trees at the point of greatest strain. Under average conditions this loss was 7 percent. This type of loss is general, but is especially marked in dense stands. On this area this loss has but just begun - how serious it may become in the future is unknown, but the decay examinations show that considerable numbers of standing trees are attacked by butt rot and carpenter ants (Camponotus herculeanus Linn.). Such trees presumably will break over too in a few years.

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* Maintained at Amherst, Massachusetts, in cooperation with the Massachusetts State College.

[1] Division of Forest Pathology, Bureau of Plant Industry.

[2] Division of Forest Insects, Bureau of Entomology.

(Over)

It was found that stringy butt rot attacked 76 percent of all the butt rotted trees and caused 64 percent of the total cull from butt rot. Brown butt rot attacked 17 percent of all butt rotted trees and caused 20 percent of the total butt rot cull in this area. Discrepancies in totals are due to cases where ant injury occurred in butt rotted trees and cases where both butt rots occurred in the same tree so that damage by one alone was not calculated. The two butt rots attacked 42 percent of all the merchantable trees and caused 4.5 percent cull of merchantable timber. Red heart attacked 7 percent of the trees and caused a cull of 3 percent of merchantable timber, (assuming that all of the red hearted timber must be discarded). Injury by carpenter ants was rather common, 3 percent of the trees being found attacked with a cull in merchantable volume of 0.3 percent caused by ants alone. A direct relation was found between the age of the trees and the number of trees defective. No decay was found until the trees were 40 years old. The following table gives the results of this correlation.

RELATION OF AGE TO DECAY BASED ON TREES MORE THAN 1 INCH D.B.H.

Age class in years	No. of trees	No. with butt rot	No. with red heart	No. with ant injury	Total No. of defective trees	Percentage of defective trees
31-40	26	0	0	0	0	0
41-50	37	4	0	0	4	10.8
51-60	185	57+	14+	3	71	38.4
61-70	298	128+	16+	10+	143	48.0
71-80	16	9	0	0	9	56.2
Total	562	198	30	17+	227	

+ Some overlapping is due to both butt rot and red heart or ants occurring in the same tree in a few instances.

Basing vigor upon total volume, it was found that there was no decided difference between the fast-growing and slow-growing trees in decay cull percent of volume or in number of trees decayed. Because of the limited age classes represented little can be said as to the pathological cutting age. Similar work must be done in older age classes and under much more varied conditions before conclusions can be drawn for the species over the entire Northeast. Opportunities to make such cuttings are much desired.

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Technical Note No. 12

March 15, 1932

UNITED STATES DEPARTMENT OF AGRICULTURE
NORTHEASTERN FOREST EXPERIMENT STATION[1]

Amherst, Mass.

WHITE-PINE WEEVIL ATTACK ON SCOTCH PINE

by

H. J. MacAloney and J. W. Johnston[2]

Scotch pine is a common or an occasional host for the white-pine weevil (Pissodes strobi Peck) but the injury generally is slight. A greater amount of damage is done to this species by squirrels and climatic disturbances--both causing injuries sometimes mistaken for weevil injury.

The so-called "Riga" strain of Scotch pine which has been planted rather extensively throughout the Northeastern States in recent years apparently has the ability to withstand attack by the white-pine weevil. Study of 19 plots in plantations in New York and Massachusetts showed that the number of leaders, dead because of weevil attack, was very much less than the number in which eggs had been laid. In all 3,386 trees were examined; 1,110 of these had been attacked in some degree of severity, but only 39 actually died. This was only 1.15 percent of the total number of trees.

It is the opinion of the authors that the probable reasons for this apparent ability to withstand attack are the vigor of the trees and the consequent heavy flow of sap. Many of the leading shoots are nearly an inch in diameter at the base at the time of attack and by the end of the second season of growth (which is the season of attack) some of them have been as much as one and one-half inches in diameter at the base. The presence of pitch droplets exuding from feeding or egg punctures is the first evidence of attack, and those leaders most heavily attacked will have the upper portion of the preceding season's leader covered with pitch. Leaders which are killed have the wilted appearance characteristic of weeviled white pine leaders. On those which survive, the bark usually has a more or less roughened appearance, and sometimes the feeding gallery of a larva may be rather plainly outlined. This roughened area, on the leading shoot, may persist for a number of years but the shoot itself is healthy.

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[1] Maintained at Amherst, Mass., in cooperation with Massachusetts State College.

[2] Division of Forest Insects, Bureau of Entomology.

(Over)

All strains of Scotch pine may not show this ability to recover, as it is well-known that in some localities heavy infestation has been reported. But in the plantations studied, most of which are recorded as having been grown from seed from northern Europe, the number of leaders actually killed is but a small fraction of the number attacked.

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Technical Notes No. 13

U. S. Department of Agriculture
NORTHEASTERN FOREST EXPERIMENT STATION*

Amherst, Mass. March 15, 1932

Change in Form of Red Spruce After Logging

by

C. Edward Behre

In the measurement of growth of trees left standing after logging, the question has frequently been raised as to whether the increased growth near the base of the tree was indicative of total volume growth or whether the growth in the upper portions of the stem would fail to be stimulated to the same degree as at the base.

To cast light on this question detailed measurements were taken in 1924 on a number of red spruce trees at Cherry Mountain, New Hampshire, in a mixed stand of spruce and hardwoods which was to be cut over in a selective manner the following winter. From remeasurement of these trees in the summer of 1930, after almost six full growing seasons, it appears that there has been no significant change in the average of the form quotients which has increased slightly when it might have been expected to decline.

The trees which were of low form quotient at the time of release now average higher in form class while those which were of high form quotient at first now show more rapid taper. It was further found that the change in form of the individual trees was more closely associated with their form quotients at the time of cutting than any other factor. The change in form of the individual trees also showed some correlation to the diameters and heights of the trees, but these factors worked in opposite directions so that they offset one another. Length of crown also seems to affect change in form of the individual trees, but not as much as form quotient.

Increment borings taken at intervals on each tree in 1924 afforded an opportunity to conjecture as to the effect of a previous logging job which had taken place over the same area about fifty years earlier. Analysis of these cores indicated that after the earlier logging there was a great reduction in the range of form quotients of the residual trees, all tending to approach a common mean just as they have since the cutting in 1924. However, the average form quotient following the earlier cut appears

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(Over)

to have declined about five units in a period of twenty years, which is equivalent to a volume error of almost nine per cent. The effect of the earlier cutting was apparently equalized after twenty or thirty years.

After both cuttings trees in the subordinate crown classes or in the understory reacted differently than those in the dominant canopy, the former tending to increase in form quotient while the latter decreased.

From this study it may safely be concluded that change in form after logging will depend upon the character of the individual trees left, and that in general little or no significant change in the average form quotient may be expected, because trees at either extreme tend to approach a common mean.

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No. 14

U. S. Department of Agriculture
NORTHEASTERN FOREST EXPERIMENT STATION*

New Haven, Conn. April 3, 1934

Revised Suggestions for Estimating Cull in Northern Hardwoods

by

Perley Spaulding, G. H. Hepting, and M. Westveld

The following conclusions are based on studies conducted on the Gale River and Bartlett Experimental Forests in the White Mountains and on the Green Mountain National Forest, supplemented by observations in sawmills and logging areas at Easton, N. H. and Wenlock, Vermont.

The Chief Fungi

Fomes igniarius: a large, brown to black, woody fungus, brown beneath, usually entering thru wounds. Fruiting bodies indicate serious loss extending 15 feet or more in all species. Cull heavily. Occurs on all hardwoods.

Fomes nigricans: usually sterile, clinker-like, black fungus causing open wounds with protruding, swollen edges on which the sterile, black masses form. On the birches. Cull as for F. igniarius.

Fomes connatus: a small, white, corky polypore usually with moss on the upper surface. Enters branch scars, bruises, or open seams. Rot extends up and down but one or two feet from the fruiting body. An average cull of 3 feet is sufficient. Occurs primarily on the maples.

Fomes applanatus: a large, flat, woody fungus with grayish upper surface and white lower surface which blackens when scratched. Quite common as a wound parasite. Rot generally extends 4 to 6 feet in each direction from the fruits.

General

Open cat faced (Nectria) cankers on trees of pole sizes usually cripple or kill the trees before they reach maturity. In thinning operations or in early selection cuttings such trees should be removed.

Old logging scars, porcupine work, open seams, etc., if extending to the ground so as to be kept moist and open enough for ready entry of air, require a cull of 6 to 8 feet. If located 6 inches or more above the ground so as to remain dry, no cull is needed except for the mechanical injury.

If air cannot enter freely wet wounds often remain unrotted.

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* In cooperation with Yale University.

Butt rot starting at or below ground level is more serious than when starting above ground level.

Amount of interior defect is proportional to the size of defective surface knots.

Churn buttedness in a tree is no sure indication of butt rot.

Hardwood timber growing in low, wet, places is apt to be pretty defective, while on well drained soils it generally runs fairly sound.

Hardwood stands from which spruce and fir have previously been cut run heavier to defect than stands from which the cutting of softwoods has been negligible.

Sugar Maple:

Cull lightly.

Chief rot is Fomes connatus, for which average cull of 3 linear feet is sufficient.

Fruiting bodies of Fomes igniarius indicate serious loss.

Hollow butt in overmature trees usually culls 10 feet.

Decayed knots are less serious than in yellow birch.

Seams generally go deeper than in yellow birch and require a discount.

Open scars are often caused by maple borer injury. Such scars should be handled as follows:

(1) If the dead wood is kept moist by adhering head bark, rot is apt to enter. Cull such cases several feet.

(2) If the dead wood of the scar is bare and new growth below the wound is cupped so as to hold water, cull 2 to 3 feet; if not cupped, cull only for mechanical injury.

Soft Maple:

Cull heavily.

Fomes connatus is frequent; cull 3 feet each way from fruiting body.

Fomes igniarius is common; cull very heavily as fruiting bodies mean complete loss in most cases.

Swollen knots and seams are apt to indicate black heart if not rot.

Yellow Birch:

Cull moderately.

Butt rots require average cull of 3 feet at the mill.

Fomes igniarius is common. Cull 50 - 100%.

Open cankers with depressed center and swollen edges upon which irregular, black, clinker-like, rather brittle masses occur indicate heavy loss, i.e., 50 - 100%.

Low dead sprouts or branch stubs 4" to 6" in diameter and within 4 feet of the ground; if there are no fruiting bodies, scale as entirely sound.

Hollow butt in overmature trees; cull about 10 feet.

Decayed knots are more serious than in sugar maple.

Seams seldom require a discount unless they fold inward.

Paper Birch:

Cull moderately.

Fomes igniarius fruits mean nearly total loss. Open depressed cankers with black center or edges mean heavy loss - cull 75% or more.

Beech:

Fomes igniarius is common and causes 50 - 100% loss. One fruiting body on lower trunk with large rotten knot or stub on upper trunk indicates total loss.

Fomes applanatus: cull 4 to 6 feet from the fruits.

Beech is extremely deceptive as rot starts and ends abruptly, except with Fomes igniarius.

In stands where Fomes igniarius is plentiful, stems with rough, swollen knots should be culled even though no conks are in evidence.

Hollow butt originating at the ground rots up to 6 to 8 feet as a rule. If other defect shows in mid-trunk also it means total cull.

Top broken out; stub with diameter of 6 to 12 inches or more - cull 5 feet down for rot. Other defect in mid-trunk will extend cull to include it.

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Technical Note No. 15

U. S. Department of Agriculture
NORTHEASTERN FOREST EXPERIMENT STATION*

TYPE DEFINITIONS BASED ON STATISTICS OF STAND COMPOSITION

By
M. Westveld, Silviculturist

Definitions for two spruce types of wide commercial importance - the red spruce-yellow birch and the red spruce-sugar maple-beech types, have been developed from analysis of the numerical representation of the important species in typical stands. Differentiation of these two types is of considerable importance in the silviculture of the spruce-hardwood forests. These types have often been referred to in the past as the yellow birch and sugar maple sub-types in the spruce-hardwoods type. The definitions follow:

1. Red spruce-yellow birch type (yellow birch sub-type)

Conifers usually comprise over 40 percent of the stand, with red spruce and balsam fir about equally represented. Yellow birch is usually the predominant species and greatly exceeds the combined numbers of all other hardwoods present in the stand. It may comprise from 25 to 50 percent of the stand. Sugar maple seldom comprises over 5 percent of the stand.

2. Red spruce-sugar maple-beech type (sugar maple sub-type)

Conifers comprise from 25 to 45 percent of the stand, with red spruce usually much more abundant than balsam fir. Sugar maple and beech combined usually exceed the number of yellow birch by a good margin. Sugar maple usually comprises over 10 percent of the stand.

The definitions purposely avoid hard and fast percentage limits for the various species in recognition of the wide variations in stand composition that are likely to occur between small areas in both types. The definitions if applied with reasonably good judgment, should assure a high degree of accuracy in the classification of these types.

These definitions are derived from tallies of a representative block of 30 acres in the red spruce-yellow birch type and of 20 acres in the red spruce-sugar maple-beech type, both located in the White Mountain National Forest, N. H. The definitions were found to apply without change to 5 acre units within each block as well as to the stands as a whole.

Reports of checks on these definitions from other parts of the region would be welcomed by the Station.

October 1934

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Technical Note No. 16

U. S. Department of Agriculture
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A SUCCESS INDEX FOR YOUNG FOREST PLANTATIONS

By

H. F. Morey, Assistant Silviculturist

Increased forest planting activities have accentuated the need for a yardstick by which the relative success of young forest plantations may be easily obtained. Such a measure of success has been developed and is being used experimentally by the Northeastern Forest Experiment Station.

Since the success criteria of young plantations are the same (survival and height-growth), regardless of the reason for planting, while those of the older plantations vary with the purpose of the plantations, a single success index would not be applicable to plantations of all ages. The proposed success index is based upon data from plantations whose total age ranges from three to fifteen years. They may be used to determine a relative success index (i. e. comparing one plantation with another) which is based upon survival and height-growth, or they may be used to compare the height-growth of the plantation in question with that of the average upon which the chart is based.

Before the chart is used total age, average total height, and survival percent of the plantation must be obtained. Success index is obtained by setting a straight edge on the indicated age on the total age scale (a) and on the indicated height on the total height-scale (h). Extend the straight line thus produced to the "0" axis. Re-set the straight edge on the intersection on the "0" axis and on the indicated survival percent on the survival-percent scale (p). Read success index on the Su.I scale. Assume that a given plantation had been planted three years and the planting stock was three years old at the time of planting (the total age of the plantation would be six years), that the average height is one foot, and the average survival is 36 percent. By following the above instructions, the success index is determined to be approximately 14.

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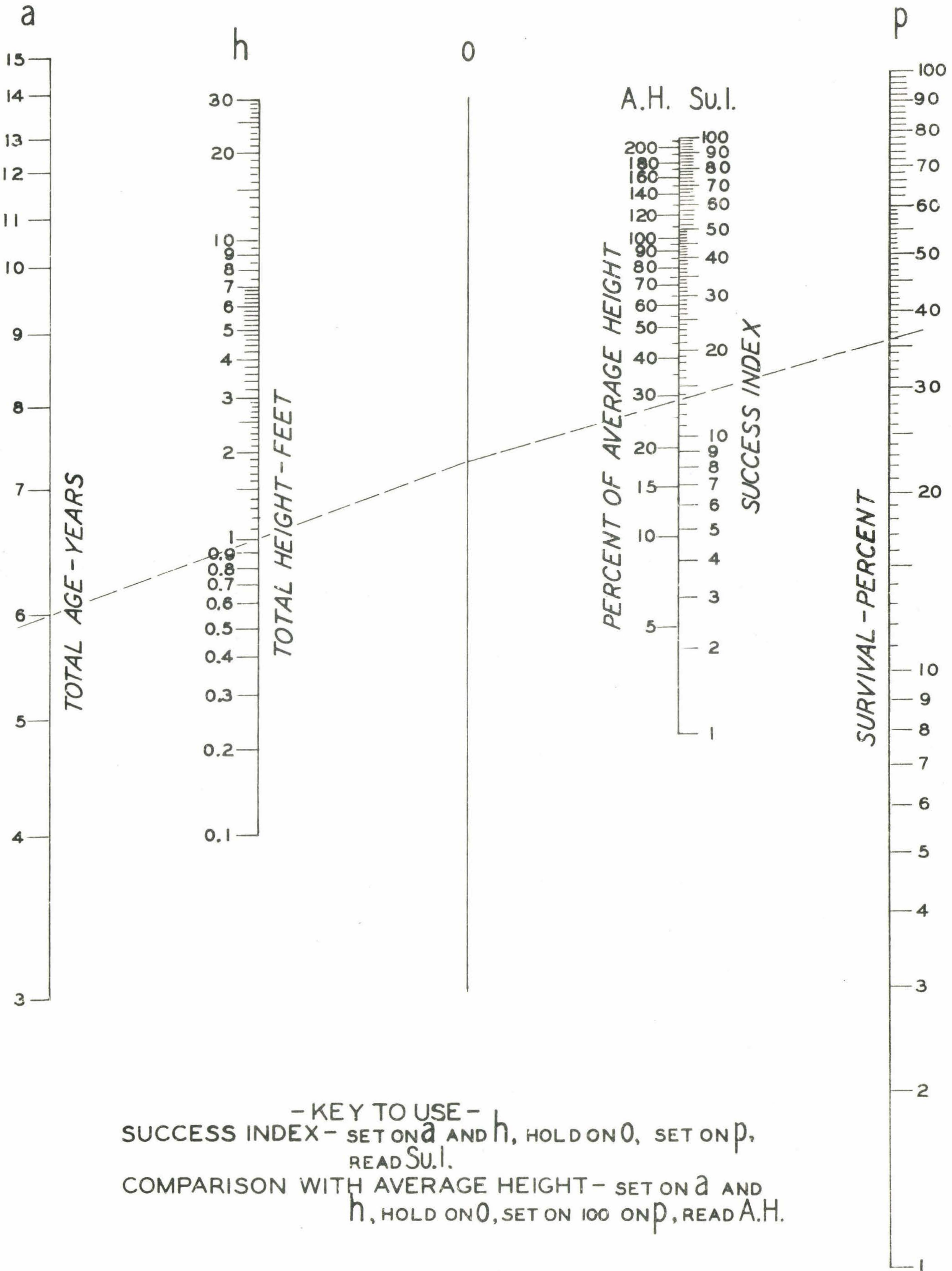
It may also be desired to know how the height-growth of this plantation compares with the average height-growth upon which the chart is based. This is done as follows: determine the point of intersection on the "O" axis of a straight line passing thru the total age and the total height (in this case, respectively six years and one foot). Pass a straight line thru the point of intersection on the "O" axis and thru 100 on the survival-percent scale (p). The point of intersection of this line on the "A.H." scale will give the desired comparison. The height of the above plantation is determined to be 80 percent of the average.

The chart for northern white pine is included in this note. Those for Norway or red pine, Scotch pine, and Norway spruce are in the process of preparation. Copies of these charts may be obtained upon application to the Director, Northeastern Forest Experiment Station, 335 Prospect St., New Haven, Conn.

April 1, 1935

SUCCESS INDEX, WHITE PINE PLANTATIONS OF 3 TO 15 YEARS TOTAL AGE.


a
h
0
A.H. Su.I.
p
TOTAL AGE-YEARS
3
4
5
6
7
8
9
10
11
12
13
14
15
TOTAL HEIGHT-FEET
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
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1
2
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30
PERCENT OF AVERAGE HEIGHT
5
10
15
20
30
40
50
60
70
80
90
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160
180
200
SUCCESS INDEX
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
SURVIVAL-PERCENT
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100

- KEY TO USE -

SUCCESS INDEX – SET ON a AND h, HOLD ON 0, SET ON p, READ Su.I.

COMPARISON WITH AVERAGE HEIGHT – SET ON a AND h, HOLD ON 0, SET ON 100 ON p, READ A.H.

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Technical Note No. 17

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CRITERIA OF FERTILITY LEVELS AS A GUIDE TO PLANTING OLD FIELDS

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By

Guy R. Stewart, Senior Forest Ecologist

When the soils of the Northeast were first used agriculturally, the grass cover of meadows and pastures was for a number of years highly nutritious. On the neutral soils Kentucky blue grass (Poa pratensis) was the dominant representative; on the more acid soils Rhode Island bent (Agrostis tenuis) and red top (Agrostis alba) flourished.

Where continuous cropping without fertilization has occurred, the loss of soil nutrients by crop removal, as well as from the annual leaching of rainfall, has produced a notable decrease in the fertility level of the land. This decrease has been accompanied by a downward succession in the value of the grassy and herbaceous cover. This was first manifested by a progressive reduction in the proportion of blue grass and bent grasses, with a corresponding increase in the prevalence of sweet vernal (Anthoxanthum odoratum) and poverty grass (Danthonia spicata). As the fertility level has dropped still lower, these poorer grasses in their turn have given way to a mixture of weeds, moss, and fern.

The above correlation between soil fertility and type of cover may be expressed as follows as a guide for the planting of abandoned farm land.

1. Sites of unusual fertility may be recognized by a cover consisting of mixtures of Kentucky blue grass and bent grasses, with 10 to 20 percent of white and red clover. With these grasses some red top (Agrostis alba) and orchard grass (Dactylis glomerata) will generally be found. Small amounts of sedge (Carex sp.) and bog rush (Juncus sp.) may occur in damper areas. The weeds present will usually be yellow buttercup (Ranunculus ficaria), dandelion (Taraxacum sp.), and small amounts of yarrow (Achillea sp.), with few, if any, daisies. Hardwoods may be expected to make their best growth on these sites.

2. Sites of average fertility will display a considerable proportion of the bent grasses and smaller quantities of Kentucky blue grass, Canada blue grass, red top, and sweet vernal. Sedges and bog rush will grow more freely in the damp portions than in those of the more fertile fields. Small amounts of clover may be present. With these forage plants there will be an appreciable mixture of daisies (Chrysanthemum sp.) yarrow, Devil's paint brush (Hieracium sp),

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moss (principally Polytrichum commune), yellow cinquefoil (Potentilla canadensis), wild strawberry (Fragaria sp), and golden rod (Solidago sp.). These sites, if well supplied with moisture, may still be adapted to the growth of hardwoods. In any case, they will be admirably suited to the more exacting conifers, such as white pine and the spruces.

3. On sites of low fertility grasses will comprise less than 50 percent of the cover. Poverty grass is the most important element with small amounts of the bents and sweet vernal also present. The balance of the cover will be made up of the herbaceous plants listed for the sites of average fertility, together with Antennaria sp., wild carrot (Daucus carota), and plantain (Plantago sp.). Any of the conifers adapted to the local climate may be planted successfully on these sites.

4. The lowest level of fertility is indicated by an absence of even the poorer grasses, with ground cover consisting chiefly of moss, Antennaria sp., and yellow cinquefoil. Norway pine, Scotch pine, and jack pine, all of which appear to have a low nutritional requirement, are the species best adapted to these sites.

February 6, 1935

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LOPHODERMIUM PINASTRI
CAUSING LEAFCAST OF NORWAY PINE IN NURSERIES

By
Perley Spaulding
Senior Pathologist
Bureau of Plant Industry, in cooperation with the Northeastern
Forest Experiment Station

Complaint has been made rather recently of a destructive leaf cast disease of young Norway pines in nursery seed and transplant beds. Our attention was called to this trouble by Mr. C. H. Foster, Director of the Pack Forest at Warrensburg, New York, who first noted it in 1930 and has watched its course in several nurseries in Massachusetts. It was so destructive that spraying was suggested. It is suspected that it is present rather generally without being recognized by nurserymen. It seems desirable, therefore, to describe it and give control measures so far as may be possible with our present knowledge.

The disease first appears in seed beds after heavy frosts in October when the needles becomea dull green or purplish-red color and appear dry. In the next spring small dead spots form and the affected needle dies back from the tip. Small, black dots form on the dead spots. These are fruiting bodies which produce spores of a simple type characteristic of the fungus but of uncertain function. Fruits of this early (pycnidial) stage borne on diseased young Norway pines from diseased beds have been authoritatively identified as those of Lophodermium pinastri, which presumably causes most of the trouble with this pine. The late (ascigerous) fruiting bodies of the fungus appear some time after the above mentioned early ones; they are slightly larger, being about 1/16 inch long, elliptical in shape, black, and may form on both sides of a needle. The diseased leaves fall prematurely, weakening and even killing one-year seedlings the spring after infection takes place. In older stock the loss has been 10 to 50 percent. The late fruits may form before the affected needles fall or they may do so while the leaves lie on the ground. The fruit bodies swell and burst open along a median line in or just after rainy weather in early or mid summer. The spores are set free and are distributed by air currents or rain drops. Infection may thus come from neighboring pine forests and it is inadvisable to locate nurseries too close to such forests for this reason. Northern white pine has been resistant to this trouble thus far.

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(Over)

This fungus has been collected on various species of pines from coast to coast fruiting in practically all of the warm months. The progress of the disease varies according to the weather, wet summers and mild winters favoring it.

In Europe forest nurserymen have given much attention to this disease and methods of control appear to have been worked out there. Bordeaux mixture double strength (4-4-25) and lime sulphur (2 percent) have been mentioned most often there as giving adequate control. Mr. Foster has successfully used the former. A "spreader" consisting of one pound of a casein soap to 25 gallons of spray mixture will prevent the needles shedding the spray when applied. Keep the mixture thoroly stirred. The spray nozzle should make a very fine, misty, spray. Spray in dry weather. The first application should be made when the new needles are about half grown. The spray is effective only so long as the deposit on the needles is bluish in color. Intervals between sprayings depend upon the weather, frequent rains making necessary more applications in shorter intervals. Normally three or four week intervals can be allowed between sprayings. Usually three applications will suffice, the last one coming at about the time seasonal growth ceases. If treatment is made of a pine species which makes a secondary growth late in the season, as in the case of northern white pine, an additional application should be made when this new growth is completed.

Under favorable weather conditions this trouble may become destructive wherever young conifers are grown. There are other closely related fungi which cause similar diseases on various conifers. Their control in the nursery presumably would be much like that above outlined. Specimens of dead and dying coniferous seedlings suspected of having this disease may be sent for examination to the Pathologist of the Northeastern Forest Experiment Station, 335 Prospect Street, New Haven, Connecticut.

March 8, 1935

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STEREUM SANGUINOLENTUM
A DANGEROUS FUNGUS IN PRUNING WOUNDS ON NORTHERN WHITE PINE

By

Perley Spaulding, Senior Pathologist, Bureau of Plant Industry, H. J. MacAloney, Assistant Entomologist, Bureau of Entomology and Plant Quarantine, in cooperation with Northeastern Forest Experiment Station, and A. C. Cline, Assistant Director, Harvard Forest.

When the present movement of pruning of white pines in plantations was initiated it was believed that *Trametes pini* was the only fungus to be feared because of its possible entry thru pruning wounds. It was then advised to limit pruning of living branches to small sizes to reduce this danger to a minimum. Considerable experimental pruning was done, branches of all sizes being cut off to learn what might happen. This proves to have been fortunate, as attention has thus been called to another fungus which appears even more dangerous to pruned conifers than *Trametes pini*.

This fungus is *Stereum sanguinolentum*. It grows as thin, flat patches on the wood or bark, $\frac{1}{2}$ to 2 inches across, several sometimes fusing into a single large one, usually with a narrow, thin, reflexed shelf at the upper edge, which projects $\frac{1}{4}$ to $\frac{1}{2}$ inch from the flat portion. The fruiting surface (the lower side of the shelf and the entire flat part) is colored a pinkish buff to gray with a tinge of lavendar, and is smooth. The upper surface of the shelf is gray to umber and hairy when seen with a hand lens.

Stereum sanguinolentum has been attracting attention in temperate North America and in northern Europe as a serious destructive agent in piles of pulpwood stored at paper mills. It is also known to be generally and widely distributed on logging slash of conifers and on dead branches on living trees thruout the north temperate zone. Of late years, however, it has appeared as causing serious losses in living trees of Norway spruce and Scotch pine in Scandinavia, and in balsam fir in Canada. The senior author and his associates have found it causing serious damage in living balsam fir in Maine, New Hampshire, and New York. In Idaho it attacks alpine fir. It has revealed a still more sinister aspect in Sweden where it has damaged living Norway spruce trees which were marked for felling and then left one or two

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years before felling. It has entered thru the blazes with which the trees were marked and has rotted the wood both upward and downward. The rot has extended rapidly, its total length averaging 2 meters in less than 2 years.

In the above mentioned pruning experiments instances were found where Stereum sanguinolentum has infected wounds where branches 3 to 5 inches were cut off and has formed fruiting bodies on the exposed wood, which was not completely covered by exuding pitch. Inwardly, the rot extends thru 6 inches of dead wood into the living trunk, where it undoubtedly extends some distance up and down in the heart wood. It thus becomes evident that pruning of living branches so large that the heart wood is not well covered with pitch is a dangerous practice. Young pruned trees in which this fungus has established itself will be worthless long before they reach a merchantable size. Herein is a new incentive to prune early before the branches get too large. In exceptional cases, where pruning wounds more than 2 inches across are made in cutting off living branches, the wound should be protected with a coat of Bordeaux paint made by mixing equal parts by weight of commercial dry Bordeaux and linseed oil.

March 8, 1935

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THE DYING OF BEECH in 1934

By
Perley Spaulding, Senior Pathologist
and
J. R. Hansbrough, Assistant Pathologist
Division of Forest Pathology, Bureau of Plant Industry
In cooperation with the Northeastern Forest Experiment Station

An extensive sudden dying of beech was noted in July, 1934 in the vicinity of Tupper Lake, New York. It is scattered in patches of various sizes up to fifty or more acres each. The striking feature of the trouble is that all ages of beech from saplings to huge, overmature veterans exhibit signs of it from mere dying of a few topmost branches to death of the entire tree. While scattering trees of other species are affected, beech is by far the most severely injured. The diseased areas are scattered westward and northward from the Tupper Lake basin to Gouverneur and Potsdam. Incidental travel has not shown it to occur eastward of the Tupper Lake basin. The sapwood of dead branches is dark in color and watersoaked in appearance. The roots and lower trunk of dead trees seem normal. Cultures made from dead and nearly dead branches showed sterile fungi present in the outer, normally colored wood and to a much less extent in the discolored wood. Inoculations have shown no results thus far. The buds on dead branches never started growth in the spring. On partly dead trees there were scattered living leaves but very abnormal in shape, size, and appearance, showing that the buds had been injured. The annual ring for 1933 was of normal thickness, indicating that the injury took place after the growing season of 1933. These facts point to the period between late fall of 1933 and May, of 1934, as being the time when injury occurred. No suspicious fungi were found fruiting on dead or dying beeches; in fact, they were remarkably free of fungous fruits. The circumstances indicate that the trouble is physiological in character. Naturally, the winter of 1933 being so extreme, led to suspicion that the disease was due to winter injury of some type.

Study of weather records does not show any peculiar condition during the winter of 1933-34 that did not prevail generally thruout the Northeast, yet this injury to beech is rather local. Apparently then, winter injury alone did not cause the trouble. Turning to the

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weather records for 1933 we find that there was a deficiency of precipitation in this exact area ranging from approximately 12 percent at Tupper Lake to approximately 16 percent at Wanakena, the two weather stations within the area. Most of this deficiency was within a continuous period of five months, June to October inclusive, or most of the growing season of 1933. While this did not cut down annual growth noticeably, it may have become rather acute by the beginning of the dormant season. The severity of the winter together with the unusual January thaw in 1934 apparently caught the beeches in poor shape to best resist what were for them critical climatic conditions. The trouble appears to be due to neither drought nor severe winter weather alone, but is a result of the effect of both.

General observations made in the Lake States in the fall of 1934 bear out this theory. The winter of 1933-34 was fully as severe there as in the East. It was followed by the very bad drought of 1934. The junior author noted that from central Michigan southward into Indiana and Ohio, where the drought was at its worst, the beech was dying in wholesale numbers. In northern Michigan, however, where the winter was just as severe but the drought much less serious, little or no injury could be found on the beech. While it is entirely possible that in the southern Michigan, Ohio, and Indiana region, the drought was severe enough to kill the beech without the additional injury from the severe winter, yet the two factors are so closely interlocked that it would be extremely difficult to separate their effects. The authors think that both there and in the New York area the drought may have been the really significant cause, but that the drought injury was probably greatly aggravated by extreme winter conditions.

March 8, 1935

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PREVENTION OF DAMAGE TO ROUND-EDGED WHITE PINE LUMBER BY WOOD-BORING INSECTS

By

H. J. MacAloney, Assistant Entomologist[1]

Any factor which increases the cost of manufacture of lumber or causes a depreciated value of the finished product is of prime importance to the white pine wood-using industries in the Northeastern states. Such a factor is the damage caused by certain roundheaded borers to lumber used in the manufacture of wooden boxes and pails. This is particularly true in the case where tight containers are desired. As a general rule, white pine used for boxes and pails is sawn round-edged in thicknesses of 1, 2, and 3 inches and is piled in the yard to air-season, unless there is immediate use for it.

Three species of borers are involved: the sawyer beetles, *Monochamus scutellatus* Say and *M. notatus* Drury and the black horned pine borer, *Callidium antennatum* Newm. The first two attack green logs and lumber while the last attacks seasoned or partially seasoned material, and a knowledge of the life histories and habits is necessary so that the maximum amount of damage can be prevented. It is well known that peeling the logs as they are cut or square-edging the lumber will prevent attack, but many mill owners claim that the financial return is too small to permit the extra cost necessary in carrying out these operations. Therefore, less costly methods are imperative. Control measures suggested by N. W. Hosley, in the Journal of Forestry, November, 1928, are used as the basis for this note. These measures were determined for the sawyer beetles, but in some degree, at least, they are applicable for the black horned borer.

The beetles of all three species emerge from the wood in the spring and early summer. They live only a short time, but as there is an overlapping in the emergence, the egg-laying period covers a considerable time - especially for the sawyer beetles. The activity of the sawyer beetles extends well into August, while that of the black horned borer ceases before the end of July. The eggs are laid in crevices or in slits cut in the bark and hatch in about two weeks. The young larvae, or grubs, bore into the inner bark, feed there for a short time and then begin to feed on the surface of the wood. This

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[1] Division of Forest Insects, Bureau of Entomology and Plant Quarantine.

feeding is superficial and does little damage. As full growth is reached the larvae bore deep into the wood, making a tunnel which runs parallel with the heartwood. It is this tunneling which causes the damage.

Damage can be prevented, or at least greatly minimized, by sawing at a time of the year when the adult beetles are not active. Lumber sawn and piled during the period from April 1 to August 15 should be utilized before fall or it will almost certainly be seriously damaged by the sawyer beetles, and may be subject to additional damage the following year by the black horned borer. Lumber sawn in early September may be subject to light attack by the late appearing sawyer beetles, but there will not be a sufficient number to cause heavy damage and it is probable that most of the young grubs will die during the winter as they will not have gone far enough into the wood to be protected from low temperatures. This lumber, however, will be subject to attack the next spring by the black horned borers as it will have seasoned. There will be little, if any, damage by the sawyer beetles to lumber sawn from September 15 to March 15, but it should be utilized before the eggs of the black horned borers are laid in the seasoned bark. Lumber sawn as late as March 15 will have seasoned sufficiently so that the young sawyer beetle larvae cannot exist because during the incubation and early larval stages there are very exacting requirements for moisture and if the tender inner bark has dried beyond these the young larvae die in a short time. The lumber piles should be raised from the ground, so that the lower tiers will dry sufficiently to prevent attack by the sawyer beetles and there should be sufficient space between the piles to permit adequate air movement to hasten the seasoning so that the lumber can be utilized before damage can be done by the black horned borer.

Logs should not be left in the woods or piled in the yards for any extended period, especially when the adults are active; they should be placed in a log pond, if one is available, to prevent attack. If it is necessary to saw the logs during the period of susceptibility to attack, the lumber should be resawn into the box or stave material as soon as possible and the bark should be removed. The presence of the borers is always apparent by the fine sawdust pushed from the tunnels by the grubs. Lumber or logs showing this evidence should be utilized immediately before the material is damaged beyond redemption.

Briefly, lumber sawn during the fall and winter months should be manufactured into the finished product the next spring and early summer; lumber sawn in the spring should be manufactured before September. No sawing should be done in June, July, and August, unless there is immediate use for the material, as this is the period of greatest susceptibility to attack.

March, 1935.

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U.S. Department of Agriculture
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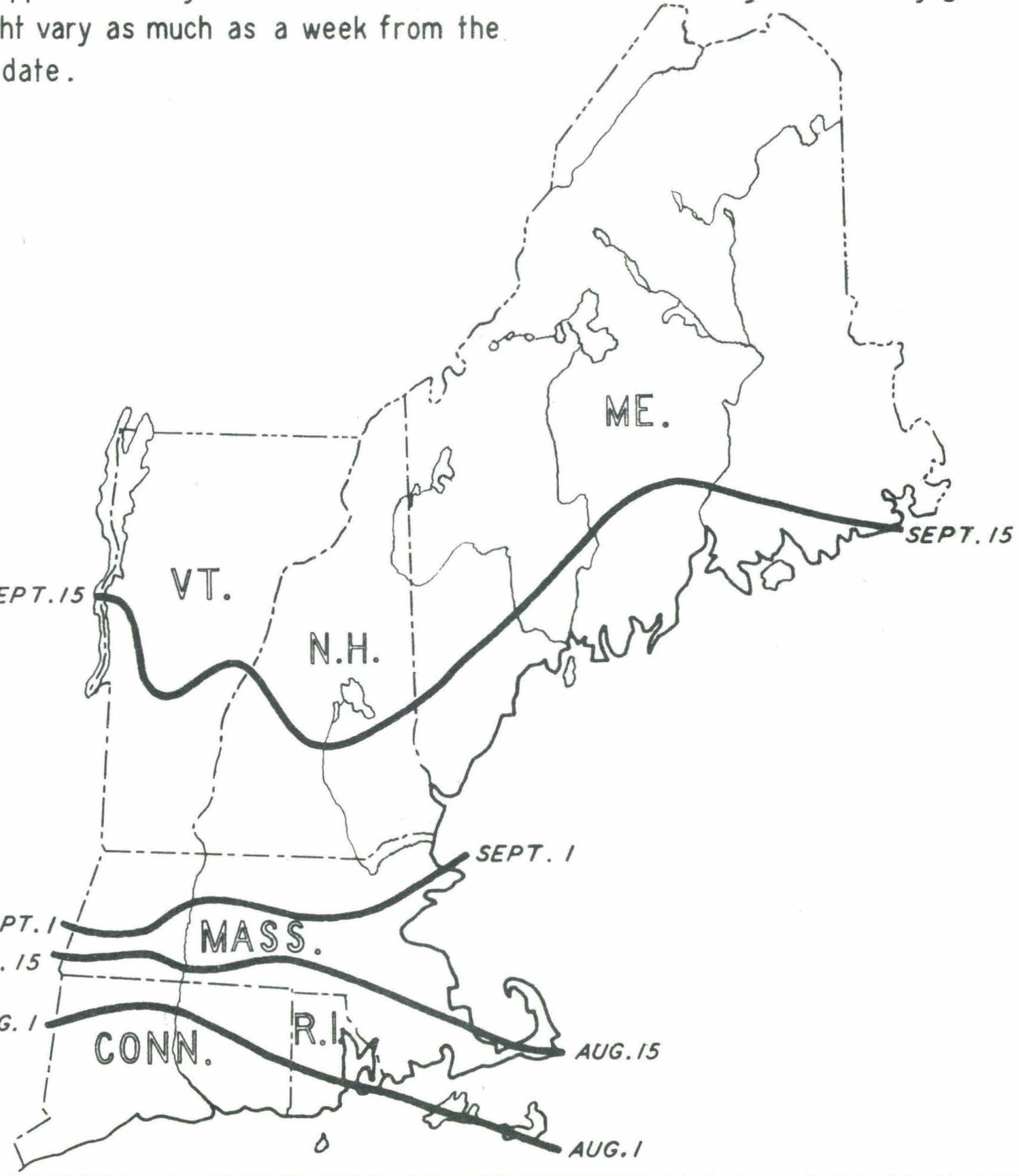
THE AVERAGE DATE OF MATURITY OF WHITE PINE (PINUS STROBUS L.) SEED

By

H.F. Morey. Assistant Siviculturist[1]

This chart is based upon observations covering five years at a number of points, supplemented by shorter records elsewhere. The maturity date for any given year might vary as much as a week from the charted date.



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* Maintained in New Haven, Conn., in cooperation with Yale University.

[1] Acknowledgment is due to observers in the Civilian Conservation Corps, Forest Schools, State Forestry Departments, and others who have cooperated in these studies. The list is too large for individual acknowledgment.

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INCREASE PRODUCTION OF SPRUCE BY GIRDLING HARDWOODS

By

M. Westveld, Senior Silviculturist

Remeasurement in 1935 of the plots in the Corbin Park girdling experiment substantiates earlier conclusions that girdling hardwoods to release spruce is a most effective measure for increasing the production of spruce. Since the preliminary report on this experiment, showing the status in 1927,[2] the plots have been measured twice, once in 1930, and again in 1935. Growth on the girdled plots has been so rapid during the past 10 years that a second progress report appears justified at this time.

In 1905 the Forest Service established a series of 3 half-acre girdling plots at Corbin Park, near Newport, New Hampshire, in a 60 year old stand of northern hardwoods containing a dense understory of spruce reproduction from 2 to 6 feet in height with a scattering of 1, 2, or 3 inch spruce saplings. In two successive cutting and girdling operations, 65 percent of the hardwoods was removed on one plot, over 90 percent on a second, while the third was left intact as a control.

Measurements at 5 year intervals following the initial girdling showed pulpwood species to be growing much more rapidly on the girdled plots than on the untreated plot. Moreover, the response to girdling was more striking on the heavily girdled than the moderately girdled plot. These facts are clearly brought out in the accompanying chart. The heavily girdled plot, which had an initial spruce volume less than the moderately girdled plot, 5 years following treatment had a greater volume than the moderately girdled plot. In 1935 the stand of spruce on the heavily girdled plot amounted to 1607 cubic feet per acre and that on the moderately girdled plot 974 cubic feet per acre in contrast with 172 cubic feet per acre on the untreated plot. Expressed on an annual growth basis, this amounts to an average of 50, 29, and 3 cubic feet respectively for the 30 year period. During the past 10 years the heavily girdled plot has been growing at the rate of 98 cubic feet per acre per year, the moderately girdled, 58 cubic feet, and the ungirdled plot less than 2 cubic feet.

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[1] In cooperation with Yale University, New Haven, Connecticut.

[2] Technical Note No. 1, Northeastern Forest Experiment Station, 1929

Of considerable interest and importance, particularly to a pulpwood operator, is the actual quantity of spruce of merchantable or pulpwood size available at a particular period. This information is also shown on the chart. Total volume is represented by the full length of the bar; merchantable volume by the white portion only. It will be noted that for the first 20 years following treatment, practically all of the material was of non-merchantable size. Thereafter, however, the percentage of merchantable material on the girdled plots rose rapidly. In 1930, 30 percent of the volume on the moderately girdled plot and 47 percent on the heavily girdled plot was of merchantable size. Five years later nearly half the volume on the moderately girdled plot and two-thirds the volume on the heavily girdled plot was of pulpwood size. This is equivalent to 4.9 cords and 11.4 cords per acre respectively. Thus, a thinning of sufficient volume to liquidate the girdling investment could be made now, leaving the growing stock in excellent condition for continued rapid development which would assure additional returns at an early date.

Ten years hence, when it is estimated the bulk of the spruce will have reached merchantable size, the net gain in softwood pulpwood attributable solely to girdling will amount to 20 cords worth $50.00 on the heavily girdled plot, and 11 cords worth $27.50 on the moderately girdled plot. The cost of the heavy and moderate girdling is estimated at $2.60 and $2.00 per acre respectively.

The following conclusions may be drawn from this experiment:

1. Red spruce stands liberated by girdling produce conifer pulpwood several times as rapidly as comparable stands not liberated.

2. Wherever a satisfactory softwood understory is present, girdling of hardwoods will convert a mixed spruce hardwood stand into a stand entirely of conifers.

3.. Even in cases in which the conifer pulpwood crop cannot be harvested until 40 or 50 years after girdling, satisfactory returns may be realized on the investment in girdling.

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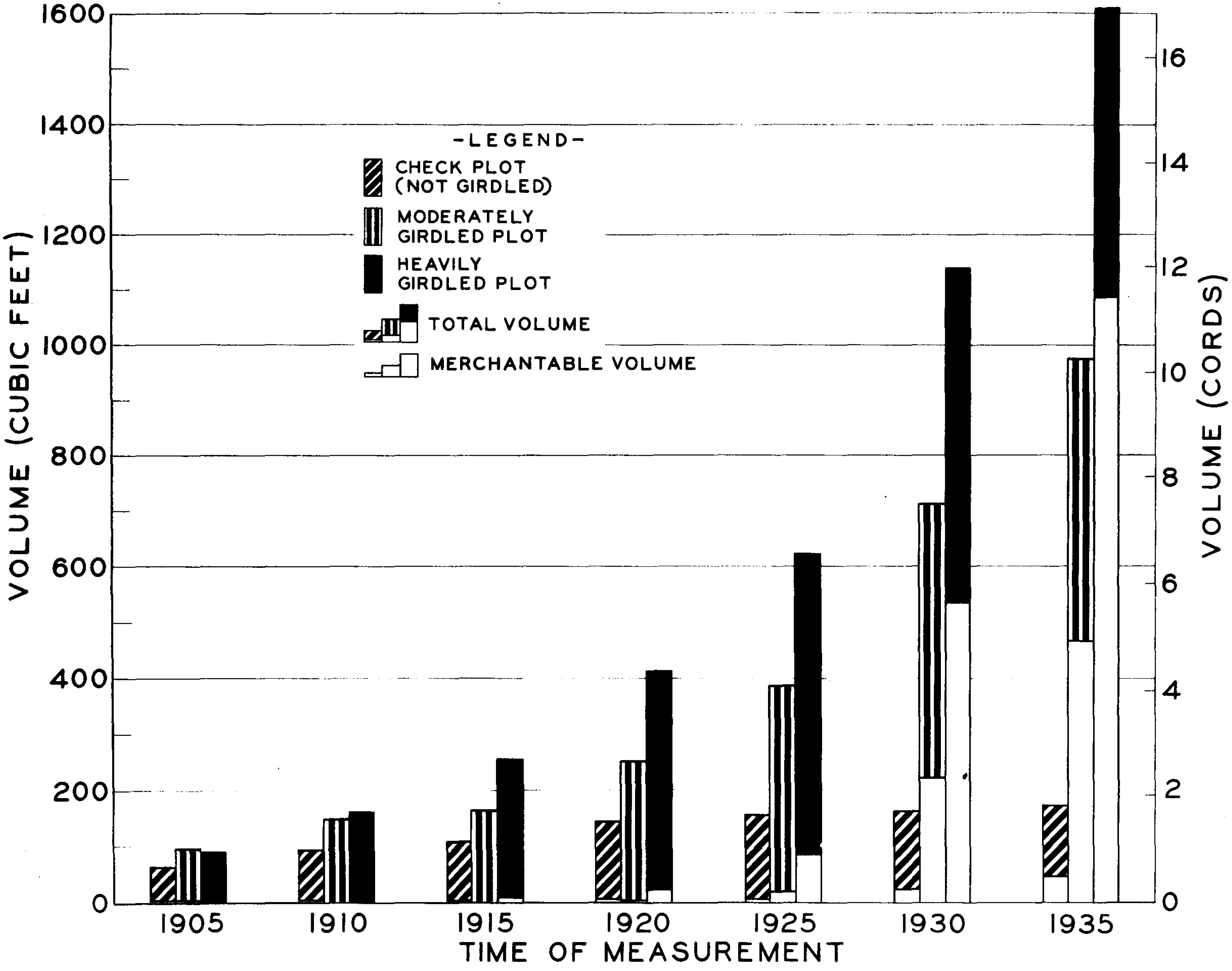
VOLUME OF MERCHANTABLE AND UNMERCHANTABLE SIZE RED SPRUCE TREES PER ACRE IN 1905 AND AT 5 YEAR INTERVALS THEREAFTER ON GIRDLED PLOTS AND CONTROL PLOTS AT CORBIN PARK, NEW HAMPSHIRE



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U. S. Department of Agriculture
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FIRE DAMAGE IN THE NORTHERN FOREST REGION

By
H. B. Shepard, Senior Forest Economist

During the field season of 1935, the forest insurance study made fire-damage appraisals on 14 burned areas in the northern forest (spruce-fir) region, aggregating 70,379 acres. The fires had occurred either one or two years previously. Most of the burned area had resulted from two very large fires, one burning a net area of somewhat over 45,000 acres, the other slightly under 21,000. These large fires covered areas which are reasonably representative of major variations in general northern forest conditions. Aside from two fires covering 52 acres in northern Vermont, the entire area studied was in northern Maine.

The results are interesting in their indication of the disastrous effect fire can have in the forests of this region. The killing of timber of merchantable size (softwoods 6" D.B.H. and over, hardwoods 10" D.B.H. and over) is shown in Table 1. The scattered timber that is left alive, particularly the hardwood, possesses very little value. Most of the trees are more or less fire-damaged, and many may be expected to succumb or deteriorate as a result of the radical change in ecological conditions.

A tally of saplings and reproduction over 1 foot in height showed that the effect of the fire was even more disastrous in this smaller growth than in the merchantable timber as is indicated in Table 2. The softwood advance growth averaged 9 feet in height and the hardwoods 12 feet.

Obviously the loss in forest values was practically complete. This helps to explain the radical change of forest type that apparently almost invariably follows fire in this region.

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[1] In cooperation with Yale University, New Haven, Connecticut.

Table 1

EFFECT OF FIRES ON MERCHANTABLE TIMBER

Northern Forest Region, New England

Merchantable Stand	On Ground Prior to Fire	Killed by the Fire	Percent Killed
Softwoods*	112,446 M.B.F.	98,135 M.B.F.	87.2
Hardwood** Sawtimber	38,812 M.B.F.	30,253 M.B.F.	78.0
Hardwood Cordwood	52,559 cords	44,298 cords	84.3
Cedar	5,067 M. Cu.Ft.	4,590 M.Cu.Ft.	90.6

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* Spruce, fir, hemlock, white and red pine.
**Chiefly beech, birch, and maple. Some associated species.

Table 2

EFFECT OF FIRES ON SAPLINGS AND REPRODUCTION

Northern Forest Region, New England

Species	Percent Stocking Before Fire	Percent Stocking After Fire	Percent Killed
Spruce	39.4	1.8	95
Fir	59.4	2.3	96
Hemlock	0.6	0.02	97
White pine	4.2	0.1	98
Red pine	1.6	0.1	94
Cedar	4.9	0.3	94
Combined conifers	81.9	3.9	95
Hardwoods	8.6	0.6	93

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NORTHEASTERN FOREST-FIRE DANGER METERS

by

Paul W. Stickel, Silviculturist

In previously published accounts[2] of the results of forest-fire weather investigations carried on by the Northeastern Forest Experiment Station in cooperation with forest schools and state forest-fire control organizations[3] alinement charts were presented for estimating duff-moisture content and degree of hazard in the open and within the forest. These charts evaluate the combined effect of three weather elements found to be intimately associated with the moisture changes in forest fuels, and hence their inflammability. From the practical aspects, the three weather elements found to be of prime value for estimating forest-fire hazard were: 1-air temperature representing the heat factors; 2-relative humidity which takes into account atmospheric moisture content, and, to a considerable degree, the drying effect of the wind; and, 3-the time elapsed since last measurable precipitation which indicates the part played by rain. All the instrumental data needed for using the alinement charts can be obtained with one instrument, a sling psychrometer.

1/ Maintained in cooperation with Yale University, New Haven, Conn.

2/ The Measurement and Interpretation of Forest-fire Weather in the Western Adirondacks, N.Y.State Col.For.Tech.Bul. 34,1931: Weather and Forest-fire Hazard with Special Reference to the White Pine Region of Central New England,Mass. For. Asso. Bul. 153, 1932; Weather and Forest-fire Hazard with Special Reference to the Spruce-Fir Region of Northern Maine, 19th Biennial Report, Maine Forest Commissioner, 1933; and Weather and Forest-fire Hazard with Special Reference to the Upper-Altitudinal Spruce-Balsam Fir Region of Northern New York, Jour.For. 32(1), 1934.

3/ The New York State College of Forestry, The Harvard Forest, The New York State Conservation Department, and the Maine Forest Service.

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Although the alinement charts have served a very useful purpose in helping to eliminate the old experience-judgment basis for evaluating the forest-fire situation from day to day and have been used to good advantage in determining forest-fire control action, they have not gained wide-spread use by local fire wardens and rangers because of certain inherent characteristics. The charts are essentially an office rather than a field device. Their most serious defect lies in the fact that they fail to indicate the type of forest-fire control organization and action that should be taken to handle effectively the changing fire load from day to day. This last-mentioned point is of particular importance, because with the development of better forest-fire control practice in the Northeast continued efficiency can be sustained by field organizations only if a degree of preparedness is maintained commensurate with the degree of forest-fire danger.

In order to meet more fully the needs of protective organizations, the Northeastern Forest Experiment Station, in cooperation with the Conservation Departments of Massachusetts and New York, has prepared forest-fire danger meters for the white pine, mixed northern hardwoods, and spruce-fir forest regions. This scheme for measuring fire danger was developed by H.T. Gisborne of the Northern Rocky Mountain Forest Experiment Station, in 1931, and has been used in northern Idaho and western Montana with great success.

The Northeastern forest-fire danger meters are based largely upon the data contained in the previously issued alinement charts. The same three weather elements --air temperature, relative humidity, and time since end of last rain--are used in integrating the natural control of fuel moisture and inflammability, but the resultant is expressed on a numerical scale of fire-danger classes from 1 (no danger) to 7 (extreme danger). Since wind velocity is also an important element in affecting the rate of spread and difficulty of control fire when once it has started, this factor is taken into account in the danger meters.

The variations in hazard and inflammability of the seven fire-danger classes recognized by the danger meters and the appropriate administrative fire-control action that is suggested as being justifiable for each class are shown in Table I. It will be noted that the meters call for an organization of fluctuating strength, varying to meet the changes in fire danger. This is conducive to both financially sound fire-control planning and efficient fire-control action.

In addition to affording a simple and accurate means of rating forest-fire danger day by day, the danger meters are of value in other ways. When the current class of fire danger is combined with a daily forecast of weather, all the information is then available upon which to predicate a forecast of the class of fire danger that may reasonably be expected to prevail in the near future. Furthermore, since numerical values have been assigned to the classes of fire danger, such values can be added and averaged into concrete expressions of the severity of fire danger of any individual month, fire season, or year. Such averages, when compiled for separate local field units, indicate the severity of conditions encountered; and, when these averages are used in conjunction with number of fires, area burned, damages, and cost, they permit a more reasonable method of rating the efficiency of individual control units than is in use at present. Finally, the data obtained from the danger meters can be used in determining the permanent needs of different control units, because such fire-danger measurements form the basis of making a comparative study of the normal danger on each area.

August 5, 1938.

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TABLE I. VARIATIONS IN HAZARD AND INFLAMMABILITY OF FOREST-FIRE DANGER CLASSES INDICATED BY NORTHEASTERN FIRE-DANGER METERS AND SUGGESTED ADMINISTRATIVE ACTION

FIRE DANGER CLASSES	HAZARD AND INFLAMMABILITY	SUGGESTED ADMINISTRATIVE ACTION
1	NONE: fires will not start from ordinary firebrands, nor will brush-pile fires or campfires spread beyond immediate edge.	No special fire-control action needed.
2	VERY LOW: fires will start from camp and brush fires, but spread will be very slow.	Cancel all brush-burning permits; man lookout points covering specially dangerous areas such as slash areas, intensively used recreational areas, and logging operations.
3	LOW: fires will start from matches, and brush and camp fires, and spread moderately fast.	Man all regular lookout points; establish primary patrol systems.
4	MEDIUM: fires will start from such smokers' materials as matches and pipe heels, and from brush and camp fires and spread rapidly as they increase in size.	Hold specially trained suppression crews ready for immediate action.
5	HIGH: fires will start from all smokers' materials save cigarettes, locomotive sparks, and camp and brush fires and spread rapidly with some crowning.	Cancel all camp-fire permits; man secondary lookout points; establish secondary patrol systems; hold secondary trained suppression crews ready for immediate action.
6	VERY HIGH: fires will start from all ordinary fire brands, spread rapidly, tend to crown, and cause spot-fires.	Close forest-areas to ordinary travel and use; mobilize entire protection force for immediate use.
7	EXTREME: explosive conditions with fires starting readily from all burning materials; fires burn fiercely, crown and spot readily.	Mobilize entire forest personnel and provide for supplemental outside assistance.

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EDGING WHITE PINE LUMBER IN NEW ENGLAND

by

V. S. Jensen, Associate Silviculturist

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The hurricane of September 1938 probably destroyed more white pine timber in New England than would normally have been cut during the next 10-year period. Landowners, lumber operators, and public agencies are cooperating in an attempt to speedily salvage and find markets for the merchantable material before it is seriously damaged by insects, stains, or fungi.

The market for white pine lumber in New England is unique in that much of the material used in the local wooden-box plants is round-edged. Unfortunately, the needs of this important industry are limited and stocks already on hand are excessive. Therefore, the tendency of many small mill operators to convert large quantities of windthrown timber into round-edged box-boards is likely to depress the selling price and make a satisfactory turnover difficult, if not impossible. When properly manufactured and merchandised, square edged white pine lumber is well adapted to a large number of uses. While it must meet competition from southern and western woods, it should be possible for native white pine to regain part of the market for certain grades of material, particularly for general construction purposes.

Edging should prove an important factor in improving the market for white pine lumber and therefore merits the serious consideration of the "round-edged" operator. Edging on the headsaw is a very questionable practice being slow, wasteful, and relatively expensive. On the other hand, the cost of even a new edger suitable for a small or medium-sized mill is not exorbitant; less than $300 installed. At the present time there is a spread of about $10 per thousand between the mill run selling price of round-edged and square-edged lumber. Production cost studies on typical New England white pine operations indicate that the board foot volume loss in making the conversion averages 21 percent. Thus 1,000 board feet of round-edged lumber worth $15 may be converted into 790 board feet of squared lumber worth $19.75, a margin of $4.75. As $1.00 is a liberal estimate of the total cost of edging a thousand board feet of round-edged lumber, $3.75 represents a conservative estimate of the premium to be obtained for edging.

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[1] Maintained in cooperation with Yale University, New Haven, Conn.

As lumber values on a grade basis normally exceed mill run prices, this margin would be even more pronounced if the operator marketed graded lumber. With quality a consideration, edging would involve more than the removal of the wane. An edgerman, with a knowledge of lumber grades and values, would build up the proportion of lumber in the upper grades by judiciously ripping wide boards of lower grade. In addition to increasing the value of his lumber by edging, the operator can ordinarily dispose of the resulting waste, edgings, and sawdust, at a profit. The reduced volume involved in manufacturing square-edged material is also a consideration when storage facilities at the mill are limited.

Manufacturing round-edged lumber should not be arbitrarily condemned as the practice is well adapted to meet the needs of the box trade and involves the minimum waste in utilizing the short clear lengths from between the nodes of second-growth white pine timber. The production cost study indicated that because of excessive sweep or taper, about 25 percent of the average mill output could not be edged without a prohibitive amount of waste. Limiting the production of round-edged box-boards to this portion of the product will probably meet the demands of the local box industry.

Owners of windthrown white pine timber should give consideration to the better values obtainable in the manufacture of square-edged lumber before contracting to have their timber sawn into round-edged stock or before selling their timber to lumbermen not equipped to edge the product.

March 9, 1939.

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CHEMICALLY-INDUCED ROOTING OF SUGAR MAPLE CUTTINGS

By
Albert G. Snow, Jr., Junior Plant Physiologist

Preliminary results obtained during the summer of 1938 indicate that the sugar maple (Acer saccharum Marsh.) can be propagated vegetatively from greenwood cuttings. The importance of vegetative propagation, both from the practical standpoint and as an aid to the rapid advance of research in forest genetics, has been discussed by Schreiner.[2] Vegetative propagation of sugar maple offers particular possibilities in the Northeast since it is claimed that the percentage sugar in the sap of this species varies from one to six percent. If inherently high sugar producers can be found, such individuals can be multiplied immediately and their desirable characteristics can be maintained by vegetative propagation.

In the present experiments, cuttings four and six inches in length were taken from young trees on June 12, July 7, and July 19. All leaves except the upper were removed and the cuttings immersed (in lots of twenty) to a depth of one inch in various concentrations of a water solution of indolebutyric acid for 3-, 6-, 12-, and 24-hour periods. After treatment the cuttings were planted to about two-thirds their length in a peat-sand mixture in an outdoor propagating bed. The following percentage had rooted by September 28.

Percentage Rooting of Sugar Maple Cuttings

Collection Date	Length	Time in solution	Indolebutyric Acid Concentration milligrams per liter							Controls in tap water
			5	10	25	50	100	200	400	
	Inches	Hours	Percentage Rooting							
June 12	4	3	-	-	57.5	65.8	59.4	39.5	41.7	35.3
	4	6	-	-	55.0	57.9	48.1	7.5	24.2	25.0
	4	12	-	-	22.5	26.8	26.0	3.1	0.0	36.4
	6	24	-	-	62.8	41.3	17.5	3.1	5.9	35.4
July 7	4	24	15.0	55.0	55.0	30.0	20.0	5.0	-	20.0
	6	24	15.0	20.0	15.0	15.0	17.8	-	-	10.0
July 19	4	24	0.0	5.0	0.0	5.0	2.5	-	-	0.0

The results given in the table indicate that maximum rooting of sugar maple cuttings, secured about the middle of June, was obtained with a 3-hour treatment with indolebutyric acid at a concentration of 50 milligrams per liter. Treatments for 24 hours at a concentration of 25 milligrams per liter were almost as good for cuttings collected early in July. Cuttings taken after the middle of July failed to root to any appreciable extent, regardless of treatment. These data indicate that best results can be expected from greenwood cuttings taken before the middle of July.

Treatment at a concentration of not more than 50 milligrams per liter is advised because stronger concentrations had a deleterious effect if immersion lasted longer than three hours.

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[1] In cooperation with Yale University, New Haven, Connecticut.

[2] Schreiner, E. J. The possibilities of the clone in forestry. Jour. For. 37(1):61-62. 1938.

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FIRE DANGER ON RED SPRUCE SLASHINGS IN NORTHERN NEW HAMPSHIRE AS INFLUENCED BY AGE AND CONDITION OF SLASH

3.11

By

Perley Spaulding, Senior Pathologist, Bureau of Plant Industry [1]
J. R. Hansbrough, Assistant Pathologist, Bureau of Plant Industry [1]
Marinus Westveld, Senior Silviculturist, Northeastern Forest Experiment Station [2]

During 1937 and 1938 a study was made of red spruce (Picea rubra Link) slash areas to determine the influence of age and condition of slash on fire danger [3]. The majority of these areas were in the valley of the East branch of the Pemigewasset River in northern New Hampshire, but some were in the adjoining Waterville valley and a few were elsewhere in the White Mountain National Forest. In all, 172 slashings varying in age from 1 to 30 years and on areas of all aspects and degrees of steepness were examined. In elevation the areas ranged from 1500 to 3700 feet with 113 areas below 2750 feet. Table 1 shows the forest cover types on the study areas.

Table 1.-- Forest cover types of the slash areas studied. [4]

Type No.	Type name	Number of areas	Per cent
18	Red spruce	129	75
16	Yellow Birch- Red Spruce	41	24
17	Red spruce - Sugar maple - Beech	2	1
	Total	172	100

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[1] In cooperation with the Northeastern Forest Experiment Station.

[2] Maintained in cooperation with Yale University, New Haven, Conn.

[3] Glossary of terms used in fire control. U. S. Department of Agriculture, Miscellaneous Publication 70:1-22, 1930, is being revised for publication. The revision gives the definition of "Fire danger" as "A general term expressing the sum total of both the constant and the variable factors which determine whether fires will start, spread, and do damage and that determine their difficulty of control". The term is used with this meaning in this paper. The writers were assisted in estimating the fire danger by H.R.Currier, J.K.Vessey, F. Gilman, and J. Piper of the White Mountain National Forest.

[4] For description of these types see: "Forest Cover Types of the Western United States" in Jour. Forestry 30(4):451-499. 1933.

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Figure 1.--Relation of fire danger to age of slash

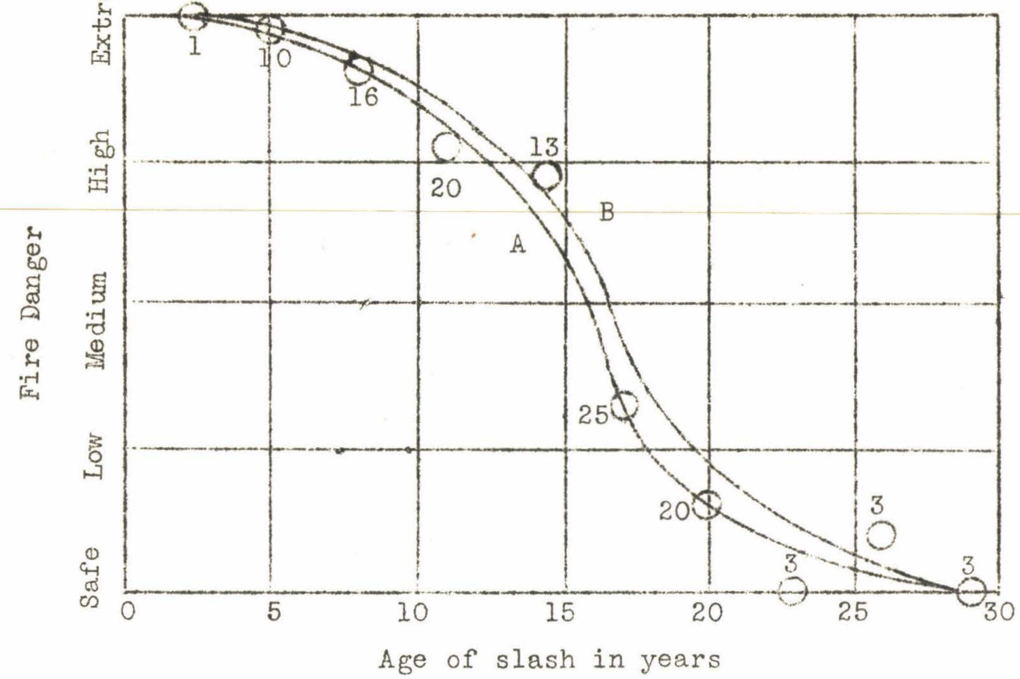
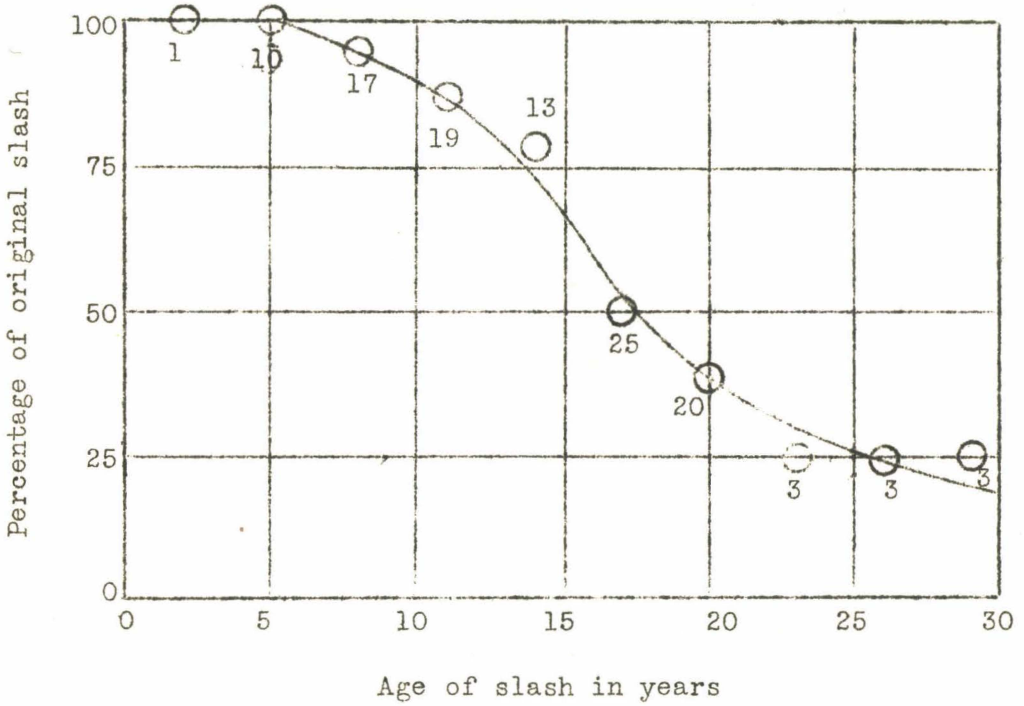


Figure 2.--Relation of volume of slash to its age.



On each area data were taken on the condition of the entire slash piles, of the top slash in the piles, of the needles and small twigs, of the small branches, and of the larger branches and trunks. In addition, the percentage of the original slash still present on the ground was estimated. These estimates are believed to be dependable because the number and position of stumps and the distribution and condition of the slash remnants made it possible, in most cases, to reconstruct the original situation satisfactorily.

Finally, an estimate was made of the degree of fire danger under the immediate, environmental conditions. The principal consideration was the relation of decay to inflammability of the slash and to rate of spread of fire. No attention was given to resistance to fire control. Five classes of fire danger were recognized. They were characterized as follows:

Extreme:	Slash bulky, covering large part of ground. Small twigs and many needles still adhering. Area completely exposed to sun and wind.
High:	Slash somewhat flattened. Twigs less than 1/8 inch in diameter fallen. Small branches dried out and frequently case-hardened. Trunks and large branches with early sap rot. Area still well exposed to sun and wind.
Medium:	Slash sunken through decay of parts close to the ground. Small branches up to 1/2 inch in diameter fallen. Branches up to 2 inches in diameter partially to well rotted. Trunks and large branches well sap rotted. Most of area shaded all or part of day.
Low:	Slash flat on the ground. All branches fallen. Trunks well rotted but intact. Canopy almost entire and well above ground.
Safe:	Conditions approaching that present in forests before logging. All branches well decayed. Trunks falling apart.

In this paper the data on fire danger and percentage of original slash still present are briefly summarized for areas less than 2750 feet in elevation without regard to slope or aspect. In general, it requires an additional 2 or 3 years at elevations above 2750 feet for conditions to reach a given degree of safety. However, the data on higher elevations are too meager to allow more than casual discussion at present.

Figure 1 shows graphically the relation of fire danger to age of slash 5/. Curve A presents the median fire danger of all the plots in each age class. There is an even chance that any one individual area may have a danger rating higher than this curve indicates. To avoid this and increase the safety factor, curve B was so constructed that 80 percent of all areas fell below it and only 20 percent above it. In other words, there is only 1 chance out of 5 that any one individual area will have a higher danger rating than is indicated by curve B. The writers recommend that curve B be used in setting up plans for administering slash areas in the White Mountain National

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5/ L.H. Reineke advised the writers on the method of constructing these curves.

Forest region. Briefly it may be interpreted as follows: Most red spruce slash areas under 2750 feet elevation will remain extremely dangerous for 5 years. By 13 years the smaller branches and debris are gone, but a high degree of danger still exists. By 17 years rot has progressed sufficiently, and reproduction has grown high enough, so that the danger is reduced to a medium condition. By 19 years the fire danger is low, and by 29 years the areas may be considered safe.

It must be borne in mind that those ratings are largely on the basis of the danger from the slash itself. Environmental conditions on any particular area may be such that the actual danger of fire inception is never high, or conversely, the danger may remain high for years longer than these curves indicate. In general, however, it is believed that these figures may be used with reasonable safety.

In Figure 2 is shown graphically the estimated amount of slash on areas from 1 to 30 years after cutting, in terms of percentage of the original slash still present. It may be interpreted roughly as follows: The amount of slash remains unchanged for 5 years, drops to 75 percent in 14 years, to 50 percent in 17 years, to 25 percent in 26 years, and then the rate of disintegration slows greatly because of the large size of the remaining slash. However, after 26 years the slash that remains is usually sparsely scattered, is apt to be damp, is well rotted, and offers little chance for fire to start in it.

The application of these data on volume reduction of slash to fire control plans is readily evident. It is obvious that there is a direct relation between the amount and condition of slash, and the ease and speed of fire line construction. Other factors remaining equal, it should require much less labor to construct fire lines 17 years after logging, when the volume of slash has been reduced by half, than it would take immediately after logging.

A marked similarity will be noted between curve B in Figure 1 and curve in Figure 2. This similarity indicates that the decline in the degree of fire danger over a period of time coincides closely with the reduction in volume of slash. The latter then may be used as a measure of the former. It follows logically that since the two curves are analogous any reduction in volume of slash will aid in reducing fire danger. This indicates the desirability of slash reduction at the time of logging in areas where the volume of slash is such that extreme fire danger exists.

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CLONAL VARIATION IN ROOTING RESPONSE OF RED MAPLE CUTTINGS

by

Albert G. Snow, Jr., Assistant Plant Physiologist

In the immediate utilization of outstanding individuals, derived either from controlled breeding in forest genetics or found occurring naturally in forest stands, one factor given primary consideration is their inherent rooting ability. The results of experimental work with red maple clearly illustrate that this factor varies from tree to tree and that some trees can be propagated as clones much more readily than others, varying from an average of 17.5 to 97.5 percent in their rooting ability.

The term "clone" is used to designate a group of plants which have originated by vegetative propagation from one individual seedling. The extent to which the clone can be useful in forestry has been fully discussed by Schreiner. [2]

Future experimental work in vegetative propagation should be based on the possible differences in the inherent rooting response of individuals. The discrepancies in the reported rooting percents obtained by different workers dealing with the same species might be explained in part by possible differences in the clones used, or inadequate random sampling of a heterogeneous population.

Experimental procedure. Six-inch greenwood cuttings from 24 different clones were taken on July 6, 7, and 8, 1939, from stump sprouts in their second growing season, and given identical auxin treatments of 200 milligrams per liter for 6 hours before planting in replicated and randomized lots in an out-door sand-peat bed. This auxin (indolebutyric acid) treatment was found to be optimum in former tests using over 1400 cuttings from at least 50 randomly selected clones. However, previous experiments have shown that red maple cuttings have a relatively large tolerance factor in relation to the concentration of applied auxin and length of treatment. In fact, a concentration x time relationship shows that within certain limits no great difference in rooting exists. Untreated red maple cuttings seldom root more than ten percent.

Three experiments were set up, the first two designed to test the differential rooting response of 8 and 12 clones respectively, and the third designed to test the variation between and within four clones. The results of a complete examination of the roots on September 15 are summarized briefly in the following three tables.

Percent Rooting of Red Maple Cuttings

Experiment No. 1

Clone No.	1	2	3	4	5	6	7	8
	Percent Rooting							
Block I	35	75	95	15	40	70	60	95
Block II	30	50	100	20	65	85	80	80
Average	32.5	62.5	97.5	17.5	52.5	77.5	70.0	87.5

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[1] In cooperation with Yale University, New Haven, Connecticut

[2] Schreiner, E. J. The possibilities of the clone in forestry. Jour. For. 37 (1): 61-62, 1938.

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Experiment No. 2

Clone No.	9	10	11	12	13	14	15	16	17	18	19	20
Percent Rooting												
Block I	80	66*	85	90	50	50	65	80	35	60	70	20
Block II	85	60	45	75	70	55*	55	40	40	55	65	65
Block III	95	60	50	80	55	60	40	35	25	50	65	45
Average	86.7	62.0	60.0	81.7	58.3	55.0	53.3	51.7	33.3	55.0	66.7	43.3

*Estimated by Fisher's missing plot technique 3/

Experiment No.3

Clone No.		21	22	23	24
Percent Rooting					
Block I	Lot 1	100	60	60	80
	" 2	90	70	90	90
	" 3	60	80	70	100
	" 4	90	90	100	90
Block II	Lot 1	100	80	60	100
	" 2	80	80	80	100
	" 3	90	70	100	90
	" 4	80	70	70	100
Averages	Lot 1	100	70	60	90
	2	85	75	85	95
	3	75	75	85	95
	4	85	80	85	95

An analysis of variance for experiments 1 and 2 indicated highly significant differences in rooting response between clones. In experiment 3 significant differences were found between clones, while the differences between lots in each clone were all within two standard deviations and could not be considered significant.

Discussion of results. Forest geneticists are continually looking for fundamental characteristics that are specific for individual trees and that set these individuals apart from any other tree or group of trees of the same species. In these experiments it was found that the rooting response of some of the clones tested differs materially from other clones or groups of clones. It is possible that this is a physiological expression of an inherent genetic difference.

Percent Rooting
Experiment No.2

Group	Clone No.	Mean %
A	9	86.7
	12	81.7
B_1	19	66.7
B_2	10	62.0
	11	60.0
	13	58.3
B_3	18	55.0
	14	55.0
	15	53.3
	16	51.7
	20	43.3
C	17	33.3

If the clones in experiment 2 are arranged in descending order of percent rooting they fall into three main groups. The clones in Group A were found to be significantly different from all clones in groups B_2, B_3, and C. The clone in Group C is significantly different from all clones in A, B_1, and B_2, while no clones in B_1, B_2, and B_3 are significantly different from each other.

This difference in rooting response of various clones may possibly be attributed either to the fact that each clone may have inherent limitations in this characteristic, or that various clones may have inherent differences in their response to definite concentrations of applied auxins in root formation on cuttings. When the rooting ability of specific clones is considered inherent, as deduced from the results of all three experiments, there is included both the natural tendency for root production, and the physiological processes whereby the applied auxin can be used in aiding this natural tendency to root. There may also be a difference in the amount or kinds of auxin produced by specific clones which augments that applied, and consequently produces optimum physiological conditions for root initiation.

It may be concluded, provisionally, that the differential rooting ability of red maple clones is conditioned most immediately either by an inherent difference in natural rooting ability, or by an inherent difference in response to specific auxin applications.

3/ Fisher, R. A. The Design of Experiments, p. 189, Second Edition, 1937.

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UNITED STATES DEPARTMENT OF AGRICULTURE
NORTHEASTERN FOREST EXPERIMENT STATION [1]

THE EFFECT OF BASAL-WOUNDING BY FIRE ON TREES IN THE NORTHEAST

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by
Paul W. Stickel, Silviculturist

In the forests of the Northeast, particularly in hardwood stands, surface fires are the general rule. Such fires, while they are destructive to the reproduction and unmerchantable-sized trees up to 2 and 3 inches D.B.H., often merely scorch the basal section of the larger merchantable trees. Until recently, fire wardens and others in making fire-damage appraisals have assumed that such basal scorching on the larger trees is of no serious consequence because trees injured in this manner are not killed outright and give every appearance of still being healthy and vigorous when examined directly after the fire.

Such is not the case, however. A recently completed study by the Northeastern Forest Experiment Station [2] has indicated that in many cases the aggregate after-effect of mere basal-wounding is more serious than the amount of immediate outright killing by surface fires. Since 1933 a number of permanent plots established directly after burning have been under observation annually. Three of the 20 plots are located in the northern forest region and two in the northeastern white pine region. These have been examined annually for six and three years respectively. The remaining 15 plots in the northeastern oak region have been maintained for between three and six years.

On all the plots, except those located in the northern forest region, a complete inventory of the stands before and after burning was made. All basal-scorched trees alive after the fire were numbered and the areas of scorched-bark were diagrammed and transferred to special field forms. At the subsequent reexamination of the numbered injured trees, those found dead were peeled and the internally injured areas were measured and superimposed on the original scorched-bark diagrams. In addition, detailed notes were taken on any attacks by insects and decay-causing organisms. All told, a total of 1086 numbered trees have been under observation.

The average post-fire condition of these stands is shown in the following table.

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[1] In cooperation with Yale University, New Haven, Connecticut.

[2] Stickel, P. W. The basal-wounding of trees by fire - a progress report. Northeastern Forest Experiment Station, Mimeo. 14 pp., illus. February 1940.

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	NORTHEASTERN OAK 6 Yrs. after Burning		NORTHEASTERN WHITE PINE 3 Yrs. after Burning		NORTHERN FOREST [1] 6 Yrs. after Burning	
	Number	Percent	Number	Percent	Number	Percent
STAND BEFORE FIRE, per acre	1213	100	1344	100		
STAND AFTER FIRE, per acre						
Trees Killed	783[2]	65	946[2]	70		
Trees Alive, Uninjured	53	4	4	1		
Trees Alive, Injured	377	31	394	29		
DEVELOPMENT ON INJURED TREES						
Died	115	31	124	32	30	52
Attacked by Fungi	91	24	12	3	5	9
Attacked by Insects	4	1	54	14	4	7
Attacked by Both Insects and Fungi	20	5	12	3	8	13
Open Fire Scar Only	41	11	48	12	5	9
No Open Fire Scar	106	28	144	36	6	10

From the above data, it is evident that on the average less than 40 percent of the trees surviving the fire fail (at a later date) to show some effects of basal-scorching, either in the form of delayed mortality, attack by insects and fungi, or the formation of an open fire scar. As a general rule, the peak of delayed mortality is reached the second year following burning, whereas practically all of the injured trees infested with bark-beetles and wood-boring insects were attacked the first year after burning. Unlike either delayed mortality or attack by insects, the infection of the injured trees by decay-causing fungi showed a definite tendency to build up for several years after the trees were injured. Thus, the peak of decay infection did not occur until the third year after the fire.

Aside from showing the significant importance of basal-scorching by fire, the data stress the need of letting burned areas "season" for several years before attempting to make a damage appraisal. From a silvicultural aspect, all scorched trees should be viewed with suspicion insofar as their future value in the stand is concerned. In order to avoid additional losses through the various detrimental after-effects mentioned above, a conservative policy is to cut severely scorched trees as soon after burning as possible.

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[1] The data for the Northern Forest region are not on an area basis; all trees observed on the three plots had been injured by fire.

[2] Almost 60 percent of the immediately-killed trees were 2 inches D.B.H. or less in size.

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Technical Note No. 31

UNITED STATES DEPARTMENT OF AGRICULTURE
NORTHEASTERN FOREST EXPERIMENT STATION 1/

SOME PRELIMINARY TABLES OF FOREST-FIRE DAMAGE VALUES FOR THE NORTHEASTERN OAK REGION 7.21

by
Paul W. Stickel, Silviculturist

In 1937, the Northeastern Forest Experiment Station initiated a forest-fire investigation, the objective of which was to develop standard regional tables of fire damages. It was believed that when the data of such tables are applied to the area figures of individual fire reports, more accurate damage values would be evolved than are indicated by the fire warden's appraisals, which, being made directly after burning, fail to take into account subsequent losses resulting from the delayed mortality and attack by insects and disease of the injured trees.

Field work of the study was conducted on areas in the northeastern oak region in Connecticut and southern New York which had been burned during the period 1934 to 1936 inclusive. A total of 24 burns were cruised by means of circular line plots on which all trees over 2 inches DBH were tallied by species groups, diameter classes, and three condition classes -- namely, live-uninjured, live-injured, and dead. On these plots similar information was obtained also on the reproduction - i.e., trees between 4½ feet in height and up to 2 inches DBH. All told, 203 cruise plots (40.6 acres) and 208 reproduction plots (4.16 acres) were established and inventoried on the 24 burned areas examined.

In calculating the volume losses due to fire, suitable non-salvage deductions were made on the injured-live trees, and such deducted volumes were added to the volume of killed material. Thus, while the values obtained are conservative and take into account the salvage possibilities on burned areas less than three years old, they are too low for older burns, where materially greater losses result from more extensive decay, breakage of basal-wounded trees, etc. By applying current stumpage prices to the

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1/ In cooperation with Yale University, New Haven, Connecticut.

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average volume losses per acre, the following monetary damages were obtained:

NORTHEASTERN OAK REGION	Sawtimber Losses Per acre	Cordwood Losses Per acre	Reproduction Damage Per acre	Total Per Acre
Softwood Cordwood Stands (Trees averaging between 3" and 6" DBH) [1]	289 bd.ft. at $5.00 per M. $1.44	3.22 cords at $0.75 per cord $2.41	$0.50	$4.35
Hardwood Stands Less Than Cordwood Size (Trees averaging less than 3" DBH) [1]	125 bd.ft. at $5.00 per M. $0.62	1.90 cords at $0.75 per cord $1.42	$0.50	$2.54
Hardwood Cordwood Stands (Trees averaging between 3" and 9" DBH) [1]	263 bd.ft. at $5.00 per M. $1.32	2.27 cords at $0.75 per cord $1.70	$0.50	$3.52

A critical analysis of the basic data used in compiling values presented above disclosed the fact that the figures have too great a deviation to be statistically accurate, so that considerable additional data are needed before reliable tables can be formulated. However, when the present damage values are compared with the damage estimates submitted by fire wardens, there is every indication that forest-fire losses are materially greater than hitherto reported. For example, by referring to the forest-fire statistics for the period 1934 to 1936 inclusive (the years during which the fires occurred which were examined in the present study), the average per acre damage by fire to timber and reproduction in Connecticut and New York was estimated to be $1.88 and $1.62 respectively. When these state figures are used as 100 and applied to the values listed in the foregoing table, the following ratios are obtained:

	Per Acre	Softwood Cordwood Stands $4.35 per acre	Hardwood Stands Below Cordwood Size-$2.54 per A	Hardwood Cordwood Stands $3.52 per acre
Connecticut	$1.88	2.3	1.4	1.9
New York	1.62	2.7	1.5	2.2

For Connecticut, the values obtained in the present study average approximately 1.9 times greater than the reported values, while for New York they are almost 2.2 times as much. For both states, the average ratio of computed to estimated damage values is 2 to 1.

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[1] The stands were composed of trees of different diameters which, however, had an average size as indicated. Thus, stands of less than cordwood size had a few trees of sawtimber and cordwood size as well as trees that were less than 3 inches DBH.

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UNITED STATES DEPARTMENT OF AGRICULTURE
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REPRODUCTION CONDITIONS ON CUT-OVER OLD-FIELD SPRUCE STANDS IN NEW ENGLAND 2.03

by

Marinus Westveld, Senior Silviculturist
and
Albert G. Snow, Jr., Assistant Plant Physiologist

Old-field spruce stands are rapidly assuming increased importance in New England as a source of pulpwood. Originating on abandoned agricultural lands they occupy soils capable of producing high timber yields. Continued use of these areas for pasturage following their abandonment, with consequent grazing-back of hardwood growth made possible the establishment of pure conifer stands. Accessibility and the ease with which the farmer could convert this resource to ready cash led to their extensive exploitation. With low prices prevailing for farm commodities, particularly during depression years, farmers in the spruce region turned to their woodlots to augment diminishing incomes. As a result, nearly every farmer in northern New England owning spruce woodland has in recent years added appreciably to his cut-over acreage.

In order to determine how successfully old-field spruce stands are regenerating and developing under the cutting methods in vogue, the Northeastern Forest Experiment Station undertook an extensive survey of old-field spruce cut-over lands in northern Vermont, New Hampshire, and southwestern Maine. Approximately 112 temporary sample plots were established in representative cuttings ranging from one to twenty-eight years old. In addition to tree and stump tallies, reproduction by species and height classes and herbaceous vegetation were tallied on transects established along the center line of each plot.

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[1] Maintained in cooperation with Yale University, New Haven, Connecticut.

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Analysis of the data has brought out a number of important facts regarding reproduction conditions on these lands. They may be briefly summarized as follows:

1. The majority of cut-over old-field spruce areas have a satisfactory amount of spruce and fir reproduction. Over 75 percent of the areas examined support in excess of 2,000 conifer seedlings to the acre while nearly half of them have in excess of 4,000 to the acre.

2. Hardwoods, however, have increased remarkably at the expense of conifers. Whereas, prior to cutting spruce and fir constituted over 90 percent of the stand on the areas examined, a preponderance of hardwoods now occurs on nearly half of such areas.

3. The average of all areas studied indicates that hardwoods and conifers are almost equally represented in the reproduction, the former averaging 5379 to the acre and the latter 5744 to the acre.

4. There is a striking excess of balsam over spruce in the incoming stand. Balsam fir constitutes over 85 percent of the conifer reproduction and spruce only 11 percent; the balance consists of white cedar, white pine, and larch in the order named.

5. Of the hardwood species present approximately 20 percent consists of weed species -- principally pin-cherry, mountain maple, and mountain ash.

6. Hardwoods, because of their numbers and rapid height growth, are overtopping the slower growing conifers and seriously hindering their normal development. Over 57 percent of all conifer reproduction present on the areas is less than one foot in height.

7. Reproduction is sparse or entirely lacking on areas occupied by dense coniferous slash.

The most significant fact brought out by the study is the success with which hardwoods are becoming established on old-field spruce cut-over areas. This encroachment of hardwoods is probably an inherent expression of the soil. It should be borne in mind that prior to clearing for agriculture, old-field spruce sites, in the main, supported chiefly hardwoods and that production of pure or nearly pure conifer stands was made possible largely through the browsing back of hardwood growth by domestic grazing stock. It is not surprising, therefore, that following the removal of conifers, hardwoods, particularly on the deeper more fertile sites, should spring up in great numbers. As only 20 percent of the hardwoods are weed species, which are usually not long-lived, untreated stands may result in fairly good mixtures of conifers and better quality hardwoods, but it is evident that weeding and release cuttings must form an integral part of any program directed mainly toward spruce and fir production following the cutting of old-field spruce stands.

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UNITED STATES DEPARTMENT OF AGRICULTURE
NORTHEASTERN FOREST EXPERIMENT STATION

RESULTS OF THINNING AND ITS EFFECT ON RESIDUAL YELLOW BIRCH AND ASSOCIATED HARDWOODS SPECIES

2.24

by

Victor S. Jensen, Associate Silviculturist

The development of residual stands following thinning or selective cutting in northern hardwoods of the Northeast has been generally unsatisfactory where yellow birch or paper birch are important components of the stand. Frequently these two species do not react favorably to exposure following cutting. This is evidenced by a dying back of twigs from the tops of the trees, which in extreme cases extends down until the tree dies. The development of epicormic branches ("water sprouts") on the bole below the original crown is commonly associated with these upper crown losses. Entomologists and Pathologists have concluded that even though the bronze birch borer (*Agrilus anxius*) and shoe string fungus (*Armillaria mellea*) are present and undoubtedly are instrumental in destroying trees, neither insect nor fungus is the primary factor in the decadence of birch.

In order to measure environmental changes following a partial removal and to observe their effect on birch and other hardwood species, an even-aged 60-year old stand on the Bartlett Experimental Forest in the White Mountain National Forest was selected for intensive study in 1931. To observe any significant differences in climatic factors, treatment was postponed for more than a year.

Following the growing season of 1932, almost half the volume of one plot was removed, while the other area, aside from designating trees that would be cut under similar treatment, remained intact for comparison. The thinning was made in a manner calculated to stimulate growth of a well distributed stand of the more desirable trees. However, as the study was particularly concerned with the development of birch after opening up the stand, this species was favored and given preference in selecting residual trees. The removal of less than one-half of the stand was a relatively conservative cut as compared with the usual commercial practice in the region.

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[1] Maintained in cooperation with Yale University, New Haven, Connecticut

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The comparison of weather data obtained after thinning on the treated and untreated plots brought out striking differences. The greatest contrast, apparent the year immediately following thinning, was very noticeable the second year, and less evident in succeeding years as the treated stand closed. The maximum air and soil temperatures were somewhat higher, and the minimum temperatures slightly lower on the thinned plot than on the check plot. Lower average and absolute relative humidities were recorded for the treated area than for the untreated area. Wind movement on the thinned plot was 50 percent greater the first season after thinning and 25 percent greater the second season after thinning than on the check plot. As might be expected, with higher temperatures, lower humidities, and more air movement on the thinned plot than on the check plot, the atmometers indicated 64 percent more evaporation the first year, and 21 percent more the second year after thinning. All the above comparative figures have been adjusted on the basis of weather data obtained the year prior to thinning, and so take into account differences inherent to the two locations.

Based on observations, the first growing season following thinning, the overstory on the treated plot appeared open but otherwise quite normal. However, late the following summer, 1934, the effects of altered environmental conditions on the thinned area were quite evident. At this time yellow birch showed signs of decadence. Epicormic branches, ordinarily considered an indication of low vigor, were noted on almost half the yellow birch, whereas these were noted on only a fourth of the trees on the check area. A dying back of twigs and tops occurred on most of the trees that had developed water sprouts. Shoe string fungus was found on several yellow birch, each of which had either a dead top, epicormic branches, or both. Other species in the overstory of the thinned area appeared generally thrifty and were developing satisfactorily. The understory, including saplings of all sizes, advance reproduction, and seedlings that had come in since cutting were making excellent growth. During the same two-year period there was little evidence of change on the check area other than the normal development of a well stocked 60-year stand.

In 1937, five years after cutting, the canopy of the thinned plot appeared much less open than immediately after cutting. Although a few trees had died, the expanded crowns of thrifty residuals more than offset these relatively slight losses. Thin or dead yellow birch tops were hardly noticeable, as either the entire tree was dead or new twigs and branches had replaced stubs. In cases where a considerable part of the top died, the new crown had a stagheaded appearance. Aside from watersprouts on a few red maple and beech the trees on the treated plot other than yellow birch appeared to be thrifty and were developing satisfactorily. The check plot in contrast with the thinned area appeared much the same in 1937 as in 1932.

Basal area as a measure of diameter growth provides an excellent indication of differences in the development of trees on the thinned and unthinned areas. The following tabulation of total growth percents indicates that on this basis, small trees made better diameter growth than the larger size-classes, and thinning stimulated the growth rate of residual trees.

Growth Percent 1932-1937 1/

Species and Treatment	Diameter Group 2/ (Inches)				Total
	1.5-3.9	4.0-7.9	8.0-11.9	12.0-16.9	
Beech					
Thin	53.7	27.7	21.3	14.1	26.0
Check	22.3	5.1	14.9	7.9	10.7
Yellow Birch					
Thin	19.6	13.0	9.3	-	11.8
Check	-	3.4	5.1	12.5	4.9
Sugar Maple					
Thin	30.0	-	-	-	10.1
Check	14.3	9.2	4.7	-	6.1
Red Maple					
Thin	64.5	13.5	22.6	-	19.9
Check	-	17.3	10.1	-	12.5
Paper Birch					
Thin	-	19.8	15.5	-	15.7
Check	-	14.2	15.0	-	14.8
All Species 3/					
Thin	49.3	14.3	16.9	13.8	18.6
Check	12.2	9.2	8.1	7.5	8.8

1/ Exclusive of trees that died or grew into 1.5" - 3.9" class.
2/ As classified in 1932 tally.
3/ Weighted Average.

As almost one-half of the original volume was removed on the thinned plot, percentages do not indicate an identical spread between volume growth on the two areas. However, the basic data indicated that in spite of the reduced residual stand, the increase in basal area of the thinned plot was greater than on the undisturbed check area. Although the smaller trees on the thinned plot made the best showing, the total basal area in the larger size groups increased slightly more than the same groups on the check area. Not only was there more new wood on the thinned plot, but as the most promising trees were reserved, this growth was being laid on trees of good quality.

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If trees that died over the 5-year period and trees that entered the 1.5" - 3.9" class are included in calculating growth on the two areas, the treated plot shows up to even better advantages. On the thinned area new trees more than offset losses by death, increasing the net growth over the 5-year period to 19.9 percent as compared with 18.6 percent. On the check plot, mortality more than offset the new trees, consequently net growth was reduced to 4.5 percent as compared with 8.8 percent indicated in the tabulation. Net growth amounts to approximately a cord per acre per year, and one-half cord per acre per year on the thinned and unthinned areas respectively.

The contrast in stands of reproduction on the thinned and check plots was even more striking than differences in the overstory. The larger openings in the stand that resulted from thinning, stimulated a growth of advanced reproduction, sprouts, and root suckers. The same openings also provided conditions favorable for the establishment of new seedlings, witch hobble, and lesser vegetation.

The hurricane of September 21, 1938 destroyed 15 percent of the volume on the plot that was thinned six years previously. On the check area, 100 yards away, only one percent of the volume was windthrown. On the Bartlett Forest relatively heavy hurricane losses in the residual stand ordinarily followed even a very light partial cutting as apparently any break in the canopy provided an entry for the wind. Because of their exposed crowns many of the tall, thrifty trees previously favored in thinning were uprooted. Also groups of trees were frequently windthrown rather than scattered individuals throughout the stand. Consequently, even though the thinned plot supported a slightly larger volume after the hurricane than immediately after thinning, prospects of developing a good stand were much less promising.

April 1, 1940.

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Technical Note No. 34

UNITED STATES DEPARTMENT OF AGRICULTURE
NORTHEASTERN FOREST EXPERIMENT STATION [1]

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EFFECT OF STICK LENGTH ON CORDWOOD VOLUME

By

L. H. Reineke, Silviculturist

It is generally recognized that the space occupied by stacked wood is influenced by length of stick, especially when the wood is rough and crooked, but factual data concerning this relationship is rather scanty. Measurements of some 50 cords of hardwood on the Bartlett Experimental Forest, Bartlett, New Hampshire, provide some interesting figures.

The wood was derived from trees of all sizes, from 2.3 inches to 22.6 inches dbh, growing in a 60-year-old northern hardwood stand containing some hold-overs from the previous generation. The entire tree was converted to 4-foot cordwood, with a minimum middle diameter outside bark of 2.0 inches. Sticks were split in accordance with local custom, halving all 8-11 and some 6-7 inch sticks, quartering those 12-16 inches, and reducing those over 16 to the equivalent of a quartered 16 inch stick. Piles contained between 1/2 and 2 cords of one species only, and included one or more complete trees. No trees were divided between two or more piles. Each pile of 4-foot wood was bucked into 16 or 12 inch lengths. The results are tabulated below.

Species	Basis 4-ft. wood	Stacked volume 4-ft. wood	Stacked volume Bucked wood	Stacked volume Shrinkage	Total vol. solid wood	Percentage of solid wood 4-ft. wood	Percentage of solid wood Bucked wood
	cds.	cu.ft.	cu-ft.	%	cu.ft.	%	%
4-ft. wood bucked to 16-inch lengths							
Yellow birch	8.2	1047.4	908.2	13.3	690.4	65.9	76.0
Paper birch	6.1	774.9	648.3	16.3	498.9	64.4	77.0
Beech	16.4	2104.5	1611.8	23.4	1237.7	58.8	76.8
Sugar maple	13.6	1736.3	1407.3	18.9	1051.9	60.6	74.7
Red maple	0.6	83.1	70.9	14.7	53.8	64.7	75.9
Totals	44.9	5746.2	4646.5	19.1	3532.7	61.5	76.0
4-ft. wood bucked to 12-inch lengths							
All species Totals	8.4	1085.1	874.3	19.4	666.5	61.4	76.2
Grand totals	53.3				4199.2	61.5	

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[1] Maintained in cooperation with Yale University, New Haven, Connecticut.

The bulk of the wood was bucked into 16-inch lengths, hence the data for this wood are most expressive of species differences. Shrinkage in the space occupied when 4-foot wood is bucked into shorter lengths, shown in the fifth column, varies widely between species, the straight and smooth birches and red maple shrinking least while the rougher sugar maple and more crooked beech display the greatest shrinkage. The wide (10.1%) range in shrinkage between species, from 13.3 to 23.4%, reflects the similar wide variation in solid content of 4-foot wood (col. 7). The range in solid content is slightly less (58.8 to 65.9, or 7.1%), but the species relationships are about the same, as might be expected.

Species distinctions disappear, however, and a high degree of uniformity in solid content results from bucking into short lengths. The last column illustrates this, solid content in percent of stacked volume differing by but 2.3% between extremes and bearing no relation to the magnitude of the shrinkage or solid content of 4-foot wood.

The data for wood bucked into 12-inch lengths were too scanty to give significance to species differences, hence totals only are given. Note the agreement between solid content of 4-foot wood for the two group totals, and the slightly higher shrinkage and solid content of 12-inch wood.

This shorter wood exhibited the same characteristic of small variation between species in solid content of bucked wood. Obviously, in 16- and 12-inch sticks, crook has been eliminated largely in the short lengths and the remaining variation may be ascribed to knots, bark roughness, and to roughness and twist of split faces.

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Technical Note No. 35

UNITED STATES DEPARTMENT OF AGRICULTURE
NORTHEASTERN FOREST EXPERIMENT STATION [1]

RABBIT FEEDING ON HARDWOODS 3.2

By

John Pearce, Assistant Biologist [2]

L. H. Reineke, Silviculturist

Rabbit damage to young plantations or natural stands varies primarily with the dietary attractiveness of the tree species present. Where rabbit control is unfeasible food preferences [3] become important, but seeming preferences may be modified by variation in density of rabbit population, variety and palatability of tree species and abundance of other food, accessibility from cover and runways, and other site variables. Reliable preference indications therefore occur infrequently.

An opportunity for accurate observation developed at the Hopkins Memorial Experimental Forest, Williamstown, Mass., during the winter of 1939-40. Two-year-old hardwood cuttings of six species, lined out one foot apart in rows three feet apart and at right angles to the edge of permanent protective cover, were worked thoroughly during the winter by cottontail rabbits. Feeding occurred along the entire length of the rows and ranged in height from ground level to three feet through feeding from the snow surface. On species most frequently beset, twig clipping and bark gnawing were widespread, but little feeding was done on the less frequently chosen species.

Striking differences in the relative frequencies of selection of species are shown by Table 1. The chi-square test shows a probability far under one percent that these differences between species may be due to chance. Conscious selection of species thus indicated is shown still more vividly by Table 2, comparing adjacent rows. The minor feeding on black locust is of particular interest since rabbit pellets,

TABLE 1. - DAMAGE FREQUENCY BY SPECIES

Species	Total No. of trees	Trees damaged	
		No.	%
Kentucky coffee tree (Gymnocladus dioicus)	133	133	100.0
Honey locust (Gleditsia triacanthos)	503	499	99.2
Hardy catalpa (Catalpa speciosa)	193	188	97.4
Black locust (Robinia pseudoacacia)	175	44	25.1
Hackberry (Celtis Mississippiensis)	101	18	19.9
Red mulberry (Morus rubra)	32	0	0.0

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[1] Maintained in cooperation with Yale University, New Haven, Connecticut.

[2] Bureau of Biological Survey, Department of the Interior.

[3] "Preference" is here used in the sense of indicating priorities among two or more alternative foods and does not connote a positive liking or relish for any one or more.

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TABLE 2. - COMPARISON OF ADJACENT ROWS

No. in row	Species	Tot. no. damaged	Degree of damage
32	Honey locust	32	Very severe
32	Red mulberry	0	None
30	Honey locust	30	Severe
38	Black locust	0	None
71	Kentucky coffee tree	71	Very severe
68	Black locust	22	Slight on 21
68	Catalpa	68	Moderate
69	Black locust	22	Slight on 19

most numerous beneath the locust, indicate the rabbits spent much time among them, possibly because this species offered better shelter than the others.

As exhibited by the tabulated evidence, rabbits distinctly prefer Kentucky coffee tree, honey locust, and hardy catalpa to black locust, hackberry and red mulberry, this preference being reflected by both frequency and intensity of feeding. The lesser use of black locust, hackberry, and red mulberry does not, however, necessarily signify aversion to these species; the small damage sustained may have resulted merely from the buffering effect of other more desirable foods, suggesting the possibility of protecting the principal species of plantations by concurrent inclusion of buffer species, particularly when the principal species is not common in artificial or natural stands in the locality.

The planting of buffer species is hardly a practical measure for the protection of natural stands. Determinations of food preferences will have their utility in evaluating the silvicultural harm or benefit of rabbit feeding and suggesting silvicultural measures for minimization of damage or profiting from rabbit activity.

Extensive feeding by snowshoe rabbits in two sample plots in a 21-year-old stand of northern hardwoods near Kingfield, Maine, provided an opportunity for analysis of feeding characteristics under natural conditions. The plots were about half a mile apart, each in the approximate center of a patch of young hardwoods about an acre in extent, surrounded by an older spruce-hardwood stand. The distribution of trees by species was unusually good, even for those quite sparsely represented.

Observations of damage were made in 1935, feeding having occurred in 1932-33. Feeding from the snow surface resulted in injuries as far as seven feet above the ground. A tally of injured and uninjured trees was made by species and diameter classes without recording the extent of bark injured. Table 3 summarizes the results by species, damage percentages being omitted for species sparsely represented. The chi-square test again shows a probability far under one percent that the species differences may be due to chance. Table 4 summarizes the combined findings for the two plots as to the effect of tree size on feeding habits.

The avoidance of balsam fir was so complete that a positive aversion to the species may be indicated. Paper, gray, and yellow birches were

TABLE 3. - DAMAGE FREQUENCY BY SPECIES-NATURAL STAND

Species	Plot A(.070 acre)			Plot B(.073 acre)		
	Total no.of trees	Trees gnawed No.	%	Total no.of trees	Trees gnawed No.	%
Paper birch	107	3	2.8	40	0	0.0
Gray birch	7	0	-	-	-	-
Yellow birch	-	-	-	3	0	-
*Beech	-	-	-	65	56	86.2
*Sugar maple	5	3	-	121	79	65.3
*Red maple	463	417	90.1	188	61	32.4
*Striped maple	3	3	-	26	22	84.6
Pin cherry	23	3	13.0	3	0	-
Balsam fir	62	0	0.0	14	0	0.0
*Serviceberry	21	21	100.0	-	-	-
*Witch hazel	-	-	-	19	2	10.5
*Miscellaneous	11	3	-	10	2	-
Totals	702	453	64.5	489	222	45.4

TABLE 4. - FREQUENCY OF DAMAGE BY TREE SIZE

DBH	Plots A + B		
	Total no.of trees	Trees gnawed No.	%
0"	339	320	94.4
1"	485	343	70.7
2"	90	6	6.7
3"	12	0	0.0
4"	4	0	0.0
5"	-	-	-
6"	-	-	-
7"	-	-	-
8"	2	0	0.0

avoided almost as completely as the fir, while pin cherry and witch hazel held rather small attraction for the rabbits. However, beech and the three maples were definitely preferred to birches, fir, and others. Serviceberry, on which gnawed bark areas were greatest, seemed more attractive than red maple on Plot A, but its absence from Plot B precludes a comparison with the other maples and with beech. These species preferences, however, seem to be independent of tree size, hence all species used, starred in Table 3, were grouped together to illustrate by Table 4 how feeding varied with size. The concentration of activity within the zero- and one-inch classes is notable.

Tree-size preferences show that the direct effects of rabbit activity are limited to the earliest stage of stand development. Silvicultural minimization of damage, or profit from rabbit workings, must issue from weeding operations. Apparently paper and yellow birch in any size can be released with little fear of loss from rabbit attack. Sugar maple, especially in the smaller sizes, will be open to attack always, hence individual attention may not be justified for trees under two inches. However, increased exposure of sugar maple as a group, through removal of favored food species, should be avoided. Indications are that pin cherry and gray birch can be removed without increasing exposure. As buffers for sugar maple, serviceberry and striped maple should be retained in full vigor since these species have no critical effect on stand development. Beech and red maple may serve as buffers also, but these species may impair the timber development of the stand. Topping may procure the desired release without the removal of stems, and subsequent rabbit girdling may result in effective reduction of these species without the danger of prolific sprouting attendant on cutting. The measures here suggested may be suited particularly to hardwood stands managed by a group-selection method, since the small islands of young growth produced by this system may foster concentrations of rabbits.

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Technical Note No. 36

UNITED STATES DEPARTMENT OF AGRICULTURE
NORTHEASTERN FOREST EXPERIMENT STATION [1]

PRODUCER GAS AS AN OUTLET FOR LOW-GRADE HARDWOODS

4.04

By
L. H. Reineke, Silviculturist
and
A. W. Bratton, Assistant Forester

In searching for a solution to the problem of utilizing low-grade hardwoods, the possibilities of converting wood to gas were investigated by the Marketing Committee of the Connecticut State Forest and Park Association, with some contributions from the Farm Forestry research project under way in Connecticut. In the industrial field, gas has long since proved itself an ideal fuel for heating operations because of more accurate temperature and atmospheric control, great flexibility in heating rate, and high efficiency. The manufacture of producer gas from wood is by no means new. Coal, coke, and charcoal are used extensively, coal being most important at present. Since producer gas can be used for heating and the generation of electrical power, why not supply institutions demanding heat and electricity with gas manufactured from wood?

Investigation of this possibility was made at one Connecticut State institution. Estimates of the installed cost of suitable equipment were secured and it was found that existing heating costs could be matched only by delivery of fuel at about $0.175 per million Btu. This is equivalent to wood at $4.20 per cord, or coal at $4.20 per ton. This figure resulted after due consideration had been given to initial costs, interest, depreciation, and repairs.

With the costs figured to this point, there still remained unanswered the question of water supply and its disposal after being used in the generator. If not recirculated, the water from both the primary cooling to which the gas is subject and the "scrubbing" process to remove undesirable chemicals will cause pollution if discharged into water courses. A large volume of water is used and its disposal is important and could be an expensive operation.

Consideration of all costs indicates that a reduction in fuel cost of $2.00 per cord for wood, or comparable reduction in other fuels, would be required for the producer-gas system to operate as cheaply as the present system of individually fired boilers in the scattered buildings of the institution studied. This investigation indicates that with equipment and operating costs at their present level the use of producer gas is not economical for institutions. The large initial investment is necessitated by the unusually high peak loads which in the particular in-

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stitution studied were nearly three times the average. As this is characteristic of institution demand curves, and like conditions can be assumed to exist at other institutions, initial cost therefore would be relatively high regardless of institution size. The cost of piping is a major item of initial investment when institution buildings are scattered, and can be avoided when an extensive distributing system is not needed. Operation economies through elimination of scrubbing, with attendant heat loss, are possible when the producer is close to the consuming point.

Producer gas is used successfully where the load is quite uniform, as in refrigeration plants and bakeries. It is also practical for plants working in metals, especially where combustion products causing undesirable chemical reactions can be avoided by gas purification. Notable from this standpoint is the freedom of wood gas from sulphur, so undesirable in brass metallurgy. Producer gas is used to good advantage in locations where gas is necessary to a manufacturing process and cannot be secured other than by production by the consumer. Electric power can be generated much more economically by using producer gas in internal combustion engines than by use of steam. Wood can be used to manufacture producer gas in such plants whenever it can compete in cost with other fuels, though such a favorable condition probably does not now exist in southern New England.

The investigation points to the need for further study of fuelwood production costs. It is known that wood will produce satisfactory gas but no margin exists at present for competition with other fuels.

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TEMPE, ARIZONA

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Technical Note No. 37

UNITED STATES DEPARTMENT OF AGRICULTURE
NORTHEASTERN FOREST EXPERIMENT STATION [1]

SOIL FREEZING AND FOREST COVER

By

K. T. Belotelkin, Junior Forester

An important though little-investigated problem is the relationship of soil freezing to forest cover. With the idea of determining some of the phases of soil freezing under different cover conditions, measurements of depth of frost in the ground were undertaken at the Gale River Experimental Forest in northern New Hampshire. In agreement with the exploratory character of this study, no attempt was made to analyze statistically the correlation between the depth of frost in the ground and the individual factors affecting soil freezing. Any definite trends, however, were noted and additional measurements taken in order to throw some light on the influence of some of the important factors.

The study was initiated in the fall of 1937. On three 1/10-acre plots established in the spruce flat and spruce swamp types and in an open field, measurements of frost depth were continued for three successive winters. In 1939 two additional plots, one in a fir flat, the other in a northern hardwoods type, were established and measurements continued through the winter of 1939-40. In addition to measurements on these plots, numerous borings were made in surrounding areas differing from the sample areas in drainage and soil texture. Most of the measurements were taken with a frozen-soil boring tool developed especially for this purpose by B. C. Goodell.

The depth to which frost penetrated the ground under different cover conditions is presented graphically in Figure 1. Since the results obtained in the fir flat were practically identical to those obtained in the spruce flat, the graph for the former was omitted.

The findings of the investigation are summarized as follows:

1. Forest cover has a favorable effect on early winter floods. Two factors are mainly responsible for this: (1) Delay of ground freezing prior to snowfall in soils protected by tree growth; (2) the type of freezing occurring in these soils. Under forest canopies, soils did not begin freezing until continuous low temperatures set in about the beginning of December. Moisture present in the litter, humus and upper layers

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of the mineral soil formed snow-like crystals enabling the soil to maintain a good degree of permeability far into the winter. Soils in the open field, on the other hand, began losing their permeability in early November when they began freezing solidly for several days at a time.

Observations made during and after a heavy rain in December of 1937 illustrate the effect of different types of freezing on run-off. Before the rain, freezing in the open field had reached a depth of 4 inches, in the spruce swamp 2.5 inches, and the spruce flat 1.5 inches, whereas in the open the rain of 1.78 inches thawed only 1/4 - 1/2 inches of the soil surface, with no thawing whatsoever occurring on the level portions of the site. Under the forest canopies most of the frost left the ground. What frozen patches remained in the forest were saturated with freely moving water. In the open field, water remained standing in slight depressions or ran freely along the slope. Under the forest cover no traces of free water were observed on the surface during or after the rain.

2. Depth and time of soil freezing and rapidity of thawing vary with the type of forest cover. Frost penetration was least in the hardwood plot, greatest in the spruce swamp. Thawing began and was completed earliest in the hardwood stand. The open field ranked second in this respect, followed by the spruce flat and spruce swamp in the order named. These findings can be largely explained by the varying depths of protective snow cover accumulated on the plots. Owing to effective interception of snow by dense conifer crowns, only a light mantle of snow covered the forest floor in spruce flat and spruce swamp plots. In the hardwood stand, owing to the open character of the hardwood crowns, snow cover was as deep as in the open. Another favorable factor characteristic, particularly of hardwood stands, is the presence of last year's dead forest floor vegetation which tends to enhance the insulating effects of the snow.

3. Snow cover affects soil freezing to such an extent that even slight trampling of the snow, thereby increasing its conductivity, was found to greatly affect the next remeasurement if taken too near the trampled area.

4. Thawing of the ground from the surface does not begin until the snow has melted; that from the bottom starts somewhat earlier.

5. Forest litter protects the soil from freezing, thus delaying the penetration of the frost.

6. Under softwood stands, frost remains in the ground longer than in the open or in hardwoods. The effect of this delay in thawing in softwood stands is probably not as serious as might be judged from the graph. Five to ten days (in the swamp even more) before the last vestige of frost has disappeared, small patches with no frost may be found which would provide channels for infiltration of water.

7. In poorly drained soils, frost penetrates deeper and stays in the ground longer than in soils with better drainage.

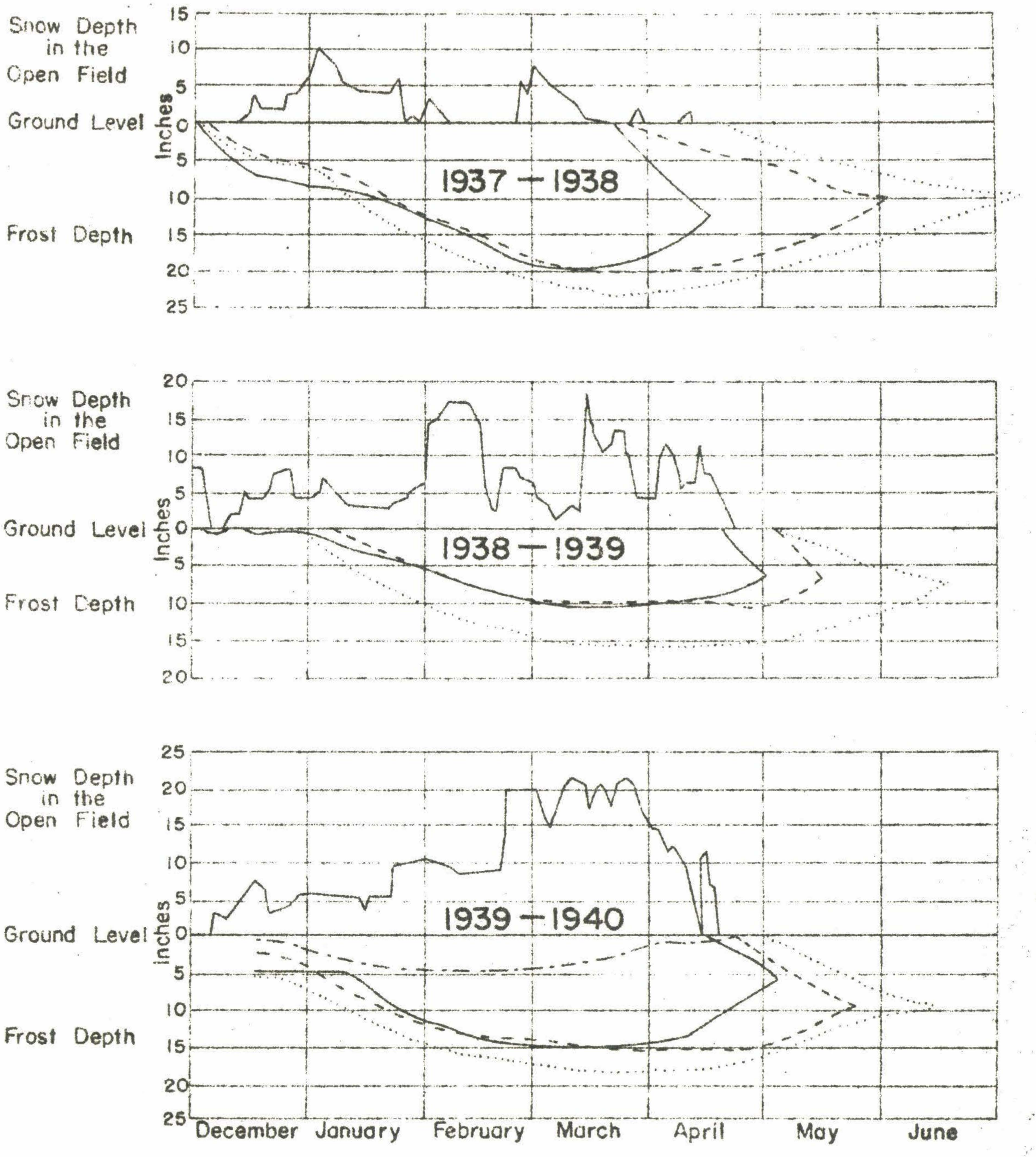
8. Fine-textured soils resemble, in their influence on soil freezing, poorly drained soils; coarse-textured soils resemble better drained soils.

September 19, 1940

FIG. 1

DEPTH OF GROUND FROST IN DIFFERENT COVER TYPES

Snow Cover and Temperature as Recorded at the Weather Station in the Open Field



Month	TEMPERATURE					
	1937-38		1938-39		1939-40	
	Mean	Av. Min.	Mean	Av. Min.	Mean	Av. Min.
November	32	25	33	23	24	16
December	18	9	21	13	20	11
January	15	4	14	4	10	2
February	20	13	20	8	14	5
March	27	17	22	10	22	13
April	42	31	33	24	34	26

LEGEND

———	Open Field
– – –	Spruce Flat
······	Spruce Swamp
–·–·–	Hardwoods

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UNITED STATES DEPARTMENT OF AGRICULTURE

NORTHEASTERN FOREST EXPERIMENT STATION[1]

EFFECT OF NEEDLE REMOVAL ON SURVIVAL OF WHITE PINE CUTTINGS

2.03

by
Albert G. Snow, Jr.
Assistant Plant Physiologist

Experience has shown that greenwood cuttings of white pine planted in outdoor propagating beds must be maintained in good growing condition well into the following summer to insure rooting. Necessarily all precautions must be observed to eliminate as many factors as possible that are detrimental to survival. A common practice among propagators to promote greater survival through minimizing transpiration is the reduction of leaf area either by entire removal of most leaves or by clipping portions of those leaves retained. This practice has sometimes been followed in attempts to root white pine cuttings. Experiments performed in conjunction with previously reported work with white pine[2] indicated that any form of reduction of leaf area was detrimental to survival in cuttings of this species.

In these experiments 4-inch cuttings of current season's growth were collected from the lower branches of a single 20-year-old white pine tree on July 14, 1939, and, after various degrees of defoliation, given a 5-hour treatment with indolebutyric acid at a concentration of 10 mg./l. before being planted in groups of 20 in replicated and randomized lots in an outdoor propagating bed. The leaf area was reduced by a combination of two methods: In some instances the needles were clipped just above the bud; on other cuttings the needles were stripped from the lower two or three inches of the cutting. The comparative effects of different methods of defoliation on survival are illustrated by the results of a survival check summarized in Table I.

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[1] Maintained in cooperation with Yale University, New Haven, Connecticut.

[2] Snow, A. G., Jr. Rooting white pine cuttings. Northeastern Forest Experiment Station. Occasional Paper No. 11. November, 1940.

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TABLE I

Percent Survival of White Pine Cuttings Accorded Various Types of Defoliation[1]

Type and degree of defoliation		Percent survival		
		Replicate A	Replicate B	Average
Top needles left intact	Lower needles left intact	55.0	50.0	52.5
	Lower 2 inches of needles removed	45.0	35.0	40.0
	Lower 3 inches of needles removed	25.0	15.0	20.0
Top needles clipped above bud	Lower needles left intact	0.0	0.0	0.0
	Lower 2 inches of needles removed	0.0	0.0	0.0

[1] Four-inch cuttings treated and planted in outdoor propagating bed July 14, 1939; survival check made October 20, 1939

It is evident from these data that any form of leaf area reduction with white pine cuttings apparently results in excessive mortality. In all cases in this, and other unreported experiments, clipping the upper needles just above the bud usually resulted in high mortality within two months. In the procedure followed most needles on the upper fourth of a 4-inch cutting were cut back more than 75 percent of their length. This invariably resulted in their complete death within a comparatively short time. Since white pine cuttings are usually inserted in the propagating medium about three quarters of their length, the death of the upper needles leaves relatively few living needles exposed and the death of the entire cutting follows shortly. Removal of the basal needles also results in considerable mortality, possibly due to the loss of reserve materials such as starches, amino acids, and growth substances that are necessary for the continued growth of the cutting. In all these instances of needle removal it is possible that early death may also be correlated with the destructive effects of fungi, as suggested by Deuber.[3] Another possible disadvantage of needle removal was found by Jacobs[4] in his experiments with cuttings of *Pinus radiata* planted directly in soil, where he observed that removing needles from the base of a cutting greatly increased their susceptibility to frost-heaving. All these factors lead to the conclusion that any form of leaf area reduction with cuttings of white pine is detrimental to immediate or ultimate survival.

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[3] Deuber, C. G. Vegetative propagation of conifers. Trans. Conn. Acad. Arts and Sci., 34:1-83. 1940.

[4] Jacobs, M. R. The vegetative reproduction of forest trees. I. Experiments with cuttings of *P. radiata*. Com. Commonwealth Forest Bur. (Canberra) Bull. 25. 1939.

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ON THE RELATION BETWEEN BARK CHARACTER AND RESISTANCE TO FIRE

1.3206

by

Paul W. Stickel
Silviculturist

It is common observation that certain species are better able to resist surface fire than others. Obviously if bark structure were uniform, the thicker the bark the greater would be its insulating capacity. But in some species, bark becomes fissured at an early age; in others, such breaks in the protective covering are slow to develop. In some species, breaks in the bark are superficial in character; in others, fissures extend almost to the cambium layer. Thus, thickness of bark in itself is an inadequate indication of relative fire-resistance. Furthermore, the anatomical structure of bark also differs in ways which materially affect heat resistance. Species which form secondary phellogen and develop layers of dead outer-bark are more resistant than those which never develop such tissue differentiation. Such anatomical differences are likely to be accompanied by differences in moisture content, which also influence thermal conductivity and sensitivity.

To facilitate interpretation of field investigations of fire damage, attention has been given to specific differences in bark character, including seasonal fluctuations in moisture content, and to the measurement of heat transmission through bark.

In connection with the latter an apparatus was devised to determine the time required for a constant source of heat applied to the surface of bark on freshly-cut bolts to raise the temperature of the cambium layer to the death point which was assumed to be 65° C. 2/ Preliminary tests made with beech, balsam fir, and hemlock are summarized in the following tabulation:

1/ Maintained in cooperation with Yale University, New Haven, Connecticut.

2/ Based on findings of Lorenz, R. W., "High temperature tolerance of forest trees", Tech. Bul. 141, University of Minnesota, October 1939.

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Bark Thickness Class	Av. In.	Species	No. Sections Cut	Av. DOB In.	Av. Age Yrs.	No. Tests	Av. Final Temp. Heat Source °C	Average time to reach 65° C. at cambium minutes
I	.10	Balsam Fir	3	5.6	40	5	300	2.64 ± 0.29
	.10	Beech	3	7.2	60	6	296	2.09 ± 0.12
II	.15	Balsam Fir	6	7.2	46	20	312	3.51 ± 0.85
	.14	Beech	4	12.3	66	16	298	3.04 ± 0.59
III	.42	Balsam Fir	3	15.2	144	13	492	6.81 ± 1.49
	.51	Hemlock	2	9.4	252	5	522	13.43 ± 0.43
						65		

For the four series of tests on thin-barked sections, initial temperatures of the heating plate were around 250° C. but for the two series on thick bark the initial temperature of the heating plate was raised to about 425° C. in order to shorten the time required for each test. This higher temperature badly charred the bark and in some cases actually caused it to burn.

It appears that beech bark offers less protection than balsam fir bark of comparable thickness. The significance of this is increased by the fact that beech requires a longer period than balsam fir to attain any given bark thickness. Thus the tests show that balsam fir 7" in diameter withstood a temperature of about 300° C. longer than beech 12" in diameter.

The role of dead outer-bark in increasing heat resistance is clearly shown by comparison of the tests for balsam fir 15" in diameter with bark 0.4" thick and hemlock about 9" in diameter with bark 0.5" thick. Dead outer-bark constituted about 78% of the total thickness in the hemlock but only 40% in the balsam fir. As a result the balsam specimens were killed in 6.8 minutes by a temperature of about 500° C. but the hemlock endured this heat for 13.4 minutes. Thus, hemlock 9" in diameter is almost twice as resistant to fire as balsam fir with a diameter of 15".

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SKIDDING IN SELECTIVE PULPWOOD LOGGING

By

K. T. Belotelkin, L. H. Reineke, and M. Westveld

It is often argued that the selective cutting of forests entails higher logging costs, particularly in the skidding operations. Aside from considerations of charging off the improvement costs, reason indicates this need not be true; first, because the locations of the individual trees determine the total ton-miles of hauling required to remove the products of one rotation, whether in one or many cuttings; second, the average skidding distance is the same for a light or heavy cut and is determined by terrain, not by total area to be cutover; third, skidding conditions under selective cutting are improved by better visibility, less slash, larger average size of cut trees, and fewer stumps (it is the base of the tree, standing or cut, which interferes with skidding, but stumps are the least visible); fourth, felling conditions are no worse and the larger average size is cheaper to fell. Much of the above reasoning is supported by factual data obtained on a partial cutting experiment on the Gale River Experimental Forest near Bethlehem, New Hampshire.

The experiment embraced an area of 95 acres of 65-year old second-growth spruce-fir averaging 16 cords of merchantable spruce and fir per acre, on a level to gently sloping but very rocky area. Ninety acres, Government-owned, were cut selectively, the remaining contiguous five acres, privately owned, being clear cut. The selectively cut area was divided into strips, each receiving a different intensity of cut ranging from 10 to 60 percent of the spruce-fir volume. The operation was handled on a strictly commercial basis. All logging was done by an experienced contractor who was under no restrictions as to methods, other than the requirement of reasonable care to avoid damages to the residual stand. Skidding was done with horses.

On 75 acres of the experimental area, peeled pulpwood was produced. Two horses, worked singly, skidded the logs in tree lengths taking one to three trees per load. Skidding time per cord dropped sharply as the load volume increased, although loads made up of two or

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[1] Maintained in cooperation with Yale University, New Haven, Conn.

Table 1
Relation of load volume to skidding time

Vol. of load	Trees per load		
	1	2	3
Cu. ft.	Minutes per cord		
5	115	141	--
10	67	80	94
15	53	60	77
20	46	47	52
25	43	39	43

three trees required more time than one-tree loads of equal volume, as shown in Table 1 for average skidding distances, which on this unit averaged 164 feet. Although the multiple-stick loads require more time per cord for a given load, the bunching and hauling time involved is more than offset by the elimination of extra return trips required if the trees were skidded singly. Table 2 illustrates this advantage in skidding multiple-stick loads. While location of individual trees or proximity to the landing may make it undesirable to bunch all trees, every effort should be made to skid loads as large as can be handled without undue animal fatigue.

Table 2
Relation of tree size to skidding time

Diam. of trees	Trees per load		
	1	2	3
	Minutes per cord		
5	255	152	131
6	146	99	80
7	100	71	57
8	76	54	42
9	60	42	33
10	53	35	--
11	47	--	--
12	44	--	--

The skidding time did not differ significantly with degree of cutting. By applying the average skidding rates to the loads taken from each strip and comparing with the time actually consumed, the differences between estimated and actual times shown in Table 3 were obtained. Swamping, rest, and other time could not be determined separately for each degree of cutting, but should not vary widely, if at all, from the average. The total costs of skidding ($1.28 per cord) were high in comparison with the contract price on the clear and partial cuttings for rough pulpwood of $1.00 per cord, but this was the result of hiring by the day instead of on a cord basis. Subcontracting of the skidding on these cuttings resulted in a saving of $0.45 per cord when costs were adjusted to a comparable basis.

Table 3
Relation of degree of cutting to skidding efficiency

Degree of cutting	Diff. from est. skidding time
Percent	Minutes per cord
10	-2
20	+4
30	+1
40	-7
50	+1
60	+4

On the remaining 20 acres of the experimental area, pulpwood was not peeled. On the 15 acres cut selectively, the total skidding costs (including swamping and other time) for the same skidding distance averaged $0.84 per cord, as compared to $0.77 per cord on the 5 acres clear cut. However, on the clear cutting, a large proportion of the small trees was not skidded, being left for bucking at the stump and sled-hauling, thus raising the average diameter of skidded trees about 1.2" above the average of the trees cut. The computed skidding cost based on skidding all cut trees on the clear-cut area is $0.88, or $0.04 higher than for partial cutting. Felling costs were $0.17 per cord higher in the clear cutting than in the partial cutting, due to felling some trees on top of others which hindered limbing, and to the necessity of piling slash in windrows to facilitate skidding. In the partial cutting, crossing of felled trees was avoided, slash piling was unnecessary, and the trees felled averaged more than an inch larger in diameter than on the clear-cut area.

It is significant to note that the operator believed, at the outset, that falling and skidding costs would be higher in the partial cuttings, but realized even before reaching the clear-cutting operation that the differences would be insignificant.

A more complete analysis of the operation will be released in a subsequent paper.

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THE PRODUCTION OF HOGGED WOOD FROM CONNECTICUT HARDWOODS

By

Allen W. Bratton, Assistant Forester

The use of hogged or chipped wood for fuel is common practice in many wood-using industries as a means of utilizing material which would otherwise be wasted. In the Pacific Northwest, both sawdust and hogged wood of coniferous species are used extensively in homes, public buildings, and power plants. Due largely to transportation costs, other fuels are expensive and competition is more easily met than in the East where coal and oil have for some time been displacing wood as a fuel.

Wood has been unable to meet this competition in the East primarily because it lacks the features of convenience and efficiency, both in handling and in combustion, found in these other fuels. The production of hogged wood offers the most convenient and efficient method of handling wood, thus holding some promise of making the production of fuelwood economically more favorable and hence providing an outlet for more low-grade forest material.

An investigation of the conversion of low-grade forest products into a form suitable for burning in automatically stoked furnaces at a price which will permit competition with other fuels has been under way during the past winter as a part of the Connecticut Farm Forestry Research Project.

Objectives of tests

To determine the costs of hogging wood in 4', 8', and 12' lengths on the basis of stacked volume and solid volume; to determine the volume of chipped wood per unit of stacked and solid-wood volume; and to devise means of improving the operation of a hog from the standpoint of rate of production, convenience, and safety.

1/ Maintained in cooperation with Yale University, New Haven, Connecticut.

Conditions of test

Wood used

Five cords each of 4', 8' and 12' wood had previously been cut, split, and piled for seasoning. All sticks over 6" in diameter had been split once and those over 8" in diameter had been split twice. The species used occurred in the following proportions:

Oak	33 percent	Sassafras	3 percent
Red maple	25 "	Yellow birch	2 "
Hickory	13 "	Yellow poplar	2 "
Gray birch	12 "	White ash, beech, and aspen	1 "
Black birch	9 "		

Equipment

A Mitts and Merrill Red Band hog was used for the tests. This hog has a single set of 12 knives mounted on a rotating 36" V-shaped cylinder, no stationary knives being employed. The actual cutting takes place at one point only, where the knives come in contact with the stick at the base of the feed spout. The particular model used weighs about 4,400 pounds, requires 60 h.p. with a shaft speed of 1,000 r.p.m. The feed spout is 12" x 12" permitting sticks up to 12" in diameter to pass. The spout is inclined so that the wood meets the blades at about a 45° angle and is gravity fed. The discharge is at the bottom.

The hog, mounted on skids, was placed over a pit which permitted a conveyor to be placed under the discharge opening. The conveyor was of "home" construction flight type, being driven directly from the hog shaft and delivering the hogged wood directly to the bodies of waiting trucks.

Power for the operation of the hog and conveyor was supplied by an International Harvester motor, Model PA-100. This model of gasoline-powered motor has a 100 h.p. rating at 1,200 r.p.m.

Methods of procedure

The equipment was set up in a wood yard in Compartment 8, Cockaponset State Forest. The wood was scooted by tractor to a point abreast of the feed spout of the hog and from there fed by one man. The stacked and solid volumes were determined previous to the hogging operation; the hogged wood was measured for volume in the truck. Gas and oil consumption of the power unit were recorded on the basis of each cord hogged.

Results

The 4' sticks show a higher operating cost than either the 8' or 12' sticks, averaging $1.73 per unit. The difference in cost between 8' and 12' sticks was found to be not statistically significant, averaging $1.15 per unit. An approximately parallel relationship can be found in the elements of labor, gasoline, and oil used, indicating the difference in cost for production of hogged wood to be in the size of the sticks. It is interesting to note, however, that the operating costs for a number of units were low, five of them averaging less than $1.00 per unit, which indicates a possibility of consistently reaching these low costs. These cost figures include a 15 percent charge for depreciation and maintenance of equipment, interest on investment, and costs of setting the equipment.

The tests show that 73.5 cu. ft. of solid wood will produce one unit of 200 cu. ft. of hogged wood. One stacked cord (128 cu. ft.) of 4' wood will produce approximately one unit of hogged wood, while stacked cords of 8' and 12' wood produce proportionately lower yields of hogged wood due to lower solid content. Solid volume of the 8' wood tested averaged 69.2 cu. ft. and 12' wood 62.0 cu. ft.

The way in which the equipment is placed has a very important bearing on the efficiency of the operation. With the small sample it was possible to run, it was not practical to go into more expensive arranging of equipment than is indicated. The hog should have been placed in a pit or in such a manner as to be lower than the cordwood, which was spotted near the hog for feeding. The desirability of such an arrangement became more apparent as the length and weight of the sticks to be handled increased.

During the tests it was found desirable to build an extension on the feed spout to support the longer lengths and to prevent sticks and ends from falling on the main drive belt. As a safety factor, such an arrangement should be used in any future set-up.

In hogging the wood, some difficulty was experienced in feeding the last 8" to 12" of each stick, since the weight of such sticks is not sufficient to hold them against the blades by gravity. Such a condition is also dangerous, since these ends would often be thrown from the feed spout with considerable force. Some models are equipped with a heavy swinging door suspended in the spout, and the model tested should be so equipped when being hand-fed. The action of these short pieces accounts to some extent for the lower cost for 8' and 12' wood, since there are fewer sticks per cord.

The one set of knives available during the tests would be most impractical for a commercial operation. At least one extra set of sharp knives should be on hand at all times, and two extra sets would be preferable to avoid delay in sharpening and replacing the dull blades. From 30 to 45 minutes are required to change blades. The knives were sharpened twice during the tests, though such frequent sharpening would not be necessary when the proper setting is learned and the knives are carefully sharpened. The knives were found to work best when set at 1/4" from the shoulders of the slots in which they were held, allowing a 1/4" clearance at the base of the feed spout. Settings of both greater and less clearance slowed the process, causing the sticks to jump around in the spout and to feed erratically.

All cost figures would be materially lower had not the hog been overpowered to the extent necessary with available equipment. The horse power could have been reduced about 30 percent, with a proportionate saving in operation costs.

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HURRICANE DAMAGE ON THE BARTLETT EXPERIMENTAL FOREST

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By

Victor S. Jensen, Associate Silviculturist

A reexamination of the Bartlett Experimental Forest's gridiron of permanent cruise plots during 1939 and 1940 provided data for analyzing hurricane damage in typical White Mountain hardwood stands. This experimental area, which includes a variety of site and stand conditions, was somewhat removed from the center of the 1938 hurricane and blowdown was not complete.

Topographic features affected windthrow in two ways. Differences in exposure were especially significant and were clearly reflected in the amount of damage. Topography was also significant because of its influence upon run-off and moisture in the soil. The 7" of rain that fell during the 2 days preceding the hurricane thoroughly saturated the soil and weakened the anchorage of forest trees. This effect was more serious along water courses and on level areas where more water could be retained than on slopes. For this reason, white ash, preferring the moist sites, was particularly hard hit although it is normally relatively wind-firm.

Wind-throw losses of hardwood species on the Bartlett Forest would undoubtedly have been much lower had the storm occurred a few weeks later when the leaves had fallen. This assumption is based on the minor losses sustained by trees recently dead or with very thin foliage, such as recently girdled trees.

Heavier hurricane losses occurred in uneven-aged than in even-aged stands, and this is attributed mainly to differences in the crown canopy. The broken canopy of the uneven-aged stands exposed the trees to the force of the wind much more than did the uniform canopy of even-aged stands. As even-aged stands develop they become less wind-resistant, not only because the crowns of older and taller trees exert more leverage on the root system during wind storms but the upper canopy becomes more and more irregular.

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Different species, largely because of differences in growth characteristics, showed varying degrees of wind-firmness, red maple being more susceptible to windthrow than any other species. Red maple sprouts, which occurred in considerable numbers, grow very rapidly, ordinarily outstripping all competitors, while as seedlings they grow fully as fast as other species. Consequently, red maple was well represented in the taller size classes. In addition to being tall, red maple sprout clumps have a larger crown area but no more extensive root system than single-stemmed trees of the same species and crown class, thus making them particularly vulnerable. Windthrow losses of paper birch and white ash, which grow in height at about the same rate as red maple, were also very heavy. The high mortality of red maple, paper birch, and white ash can largely be attributed to their exposed position in stands where slower-growing beech, yellow birch, and sugar maple were well represented. There is no indication that beech, yellow birch, and sugar maple trees of the same type, growing under identical conditions, are inherently more wind-firm than red maple, paper birch, and white ash.

Within a given stand losses were greater among the large trees than among the smaller. The damage to the smaller size classes was largely due to the trees being tipped or broken by the falling of large trees, or else to exposure after large protecting trees had fallen. Dominant trees that had developed under keen competition were especially subject to windthrow because the wind exerted unusual leverage upon the root systems of such tall slim trees with short dense crowns.

Hurricane losses were heavy on areas where part of the stand had been removed under a silvicultural partial cutting system. This was largely because crowns of the residual trees were exposed to the wind after opening up the canopy. Such stands gradually become more wind-resistant as the crowns close and the understory builds up. The value of an understory in binding the roots together and anchoring larger trees was apparent in undisturbed as well as cut-over stands. Clear cuttings indirectly affected hurricane losses on the Bartlett Forest, as windthrow was extremely heavy bordering the openings, particularly on the windward and leeward sides.

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EIGHT YEARS GROWTH IN HARDWOOD STANDS ON THE BARTLETT EXPERIMENTAL FOREST

1.314

By

Victor S. Jensen, Associate Silviculturist

Data available on the growth rate of important species in the northern hardwood forests have been largely obtained in the past on residual stands immediately following various degrees of cutting. An inventory of the Bartlett Experimental Forest, a typical 2,500-acre tract in the White Mountains of New Hampshire, followed by a reinventory approximately 8 years later, provides information on the growth and development of stands in which there has been little cutting since 1900. This tract includes only very limited virgin forest areas; part of the area has been clearcut, followed in some cases by fire; limited areas were formerly pastured or cultivated, and the remainder was culled at least twice for softwoods and high-quality hardwoods.

On the Bartlett Forest, past treatment, planned (logging) or accidental (fire), of an area largely determined the character of the present stands. The origin and character of the younger age classes, whether of seedling or sprout growth, single or multiple stems, depend to a considerable extent on previous cutting practices. Past treatment is also reflected in age and size class distribution, while site plus treatment largely determines species composition and growth rates. As stands develop, the effect of earlier cutting operations becomes less pronounced, and they tend to revert in composition and character to that of the virgin forest type.

The initial cruise at Bartlett in 1931-32 was a 5 percent sample--500 well-distributed, permanently located 1/4-acre cruise plots. With the exception of plots no longer a part of the permanent grid system because of intensive silvicultural operations, road building, and other forest improvements, the same plots were retallied in 1939-40. On different parts of the Forest this recruise was made seven, eight, or nine growing seasons after the first cruise. Normally, at least a 10-year interval would have elapsed between the two cruises, but the period was shortened in order to reinventory the area following the considerable losses resulting from the 1938 hurricane.

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The changes that occurred over an average period of 8 years also provided some indication of probable future growth trends. As an aid in analyzing the cruise plot data, these were segregated by forest types and 20-year age classes. The results are restricted to the 10 important commercial species, which account for 98 percent of the forest volume: beech, yellow birch, sugar maple, red maple, paper birch, white ash, aspen, red spruce, balsam fir, and eastern hemlock. Ordinarily growth percentages were a better measure of changes and trends than per-acre basal area growth. However, the interpretation of percent and basal area data should be properly weighed as apparently significant percentage differences are open to question if based on an inadequate sample.

Table 1 indicates, for the five major type-age classes, the average per-acre basal area in 1931-32 and 1939-40, also the average annual basal area and percent increases over the 7- to 9-year period.

Table 1

Type-age class	Av. basal area1/ (Sq.ft. per acre)		Average annual increase	
	1931-32	1939-40	Basal area1/ (Sq.ft.)	Per-cent
Northern hardwoods (all aged)	119.62	131.63	1.58	1.3
" " (41 - 60)	90.22	109.08	2.30	2.6
Paper birch-aspen-red maple (21 - 40)	72.12	84.76	1.57	2.2
" " " " " (41 - 60)	98.20	109.60	1.61	1.6
Spruce-hemlock hardwoods (all aged)	144.96	156.45	1.46	1.0

1/ Minimum 2 inch diameter class.

Growth rate, as evidenced by basal area changes from 1931-32 to 1939-40, appear to be closely correlated with species. In the five principal type-age classes on the Bartlett Forest, red maple and beech showed a marked increase in basal area over the 8-year period. As with volume, basal area increases are largely determined by the amount of growing stock. Beech made the best showing because not only was it making good growth but it accounted for three times as much basal area as red maple. However, beech, because of a somewhat slower diameter growth rate and the high mortality of large decadent trees, was surpassed by red maple on the basis of net growth percent. The vigor of red maple sprout clumps, which occurred in considerable number, particularly in the younger stands, partially account for the excellent showing of this species. Over the same period, paper birch and hemlock also showed a marked increase in basal area. Paper birch occurred largely in young stands where, as a rapidly growing, intolerant species, it was attaining a dominant position, while the extremely tolerant hemlock was building up as an understory in all forest types. Yellow birch and sugar maple, the other major species on the Bartlett Forest, showed a somewhat lower net gain in volume, averaging about 1 percent annually in the five principal type-age classes. Although the volume of white ash, red spruce, and balsam fir was relatively small, the percentage increase approximated that of yellow birch and sugar maple. The short-lived aspen (mainly trembling), an important component of the paper birch-aspen-red maple type, was rapidly dropping out of the stands with approximately a 3 percent annual decline in net volume.

Although the volumes involved may be relatively small, based on percentage, trees in the smaller size classes ordinarily make a better showing than equally thrifty large trees. Trees less than 5 inches (minimum 2-inch diameter class) grew about three times as fast as 18 inch trees of the same species. The short-lived paper birch, aspen, red maple, and balsam fir rarely attained 18 inches, but like other species showed a marked decline in growth percent rate with an increase in diameter.

The past and probable future development of the several types and age classes on the Bartlett Forest largely reflects the combined effect of species and tree size. The all-aged stands supported a greater volume, much of which is contained in large beech, yellow birch, sugar maple, and eastern hemlock. Smaller thrifty red maple and paper birch were well represented in the younger even-aged stands, while beech, yellow birch, and sugar maple, if present, were in the smaller size classes. In spite of a net basal area increase of 2.2 percent for the 21 - 40 paper birch-aspen-red maple stands as compared with 1.3 percent for the northern hardwoods all-aged stands, the net per-acre increase in basal area from 1931-32 to 1939-40 was practically the same.

Although the number of trees declined and there was a gradual increase in volume per acre on the Bartlett Forest, the proportion of species based on number of stems or volume was much the same in 1939-40 and 1931-32. Red maple, hemlock, and beech were relatively more abundant, while aspen showed a marked decline over the 8-year period. The other important species on the Forest showed a less noticeable shift, accounting for approximately the same proportion of the stand and volume in 1939-40 as in 1931-32.

The recruise of the Bartlett Forest indicated that undisturbed stands were building up in volume and, with an increase in the size of the average tree, it is fair to assume a higher ratio of better quality material. The most valuable commercial species, white ash, sugar maple, yellow birch, and red spruce, showed only a fair growth rate and accounted for about the same proportion of the stand and volume in 1939-40 as in 1931-32. During this period the net average annual increment was approximately 1,000 cords, or .4 of a cord per acre per year.

Assuming a good market for low-grade material, plus intensive silvicultural management, the Bartlett Forest could unquestionably produce a greater volume and at the same time increase the proportion of the better species to build up the quality of the residual stands. Even though growth rates were not stimulated under intensive management practices, with short cutting cycles it would be possible to increase the yield materially in harvesting trees that would otherwise die and never be utilized.

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LOG PURCHASING UNITS IN NORTHEASTERN NEW YORK STATE 4.33

by

R. D. Carpenter, Assistant Forester

One of the most confusing things in the business of forestry is the number and types of units used in the sale and purchase of sawlogs and the concomitant variations in the generally used "price per M". This situation probably is nowhere better illustrated than in northeastern New York State where, in an area about 120 miles long and 25 miles wide, seven different measures of log volume currently are used by purchasers of similar types of timber. The situation is further complicated by the lack of a standard log-grading system. Some purchasers buy log run, some buy high end of the log run, others purchase on grade. Comparative prices are, therefore, frequently a matter of conjecture.

In connection with a study of economic aspects of farm woodlands conducted in northeastern New York State by the Northeastern Forest Experiment Station, in cooperation with the Cornell Agricultural Experiment Station, the New York State College of Forestry, and the Division of Lands and Forests of the New York State Conservation Department, under funds allocated from Norris-Doxey appropriations, an analysis of the log price situation was made in order to see how woodland owners fared under the various purchase systems used. There were within the area involved 25 purchasers of logs (see Figure I). Each of these was visited and information on purchase prices of various kinds of logs was obtained. The purchasers ranged from small mill men, doing a local business in finished retail lumber, to large industrial concerns producing wholesale lumber and several types of wooden consumer goods. These operators purchase annually in the aggregate over 14 million board feet of logs, 60 percent of which is white pine, 20 percent other softwood species, and 20 percent mixed hardwoods. Softwood purchases run the gamut of grade, while hardwood purchases are confined to the higher grades only.

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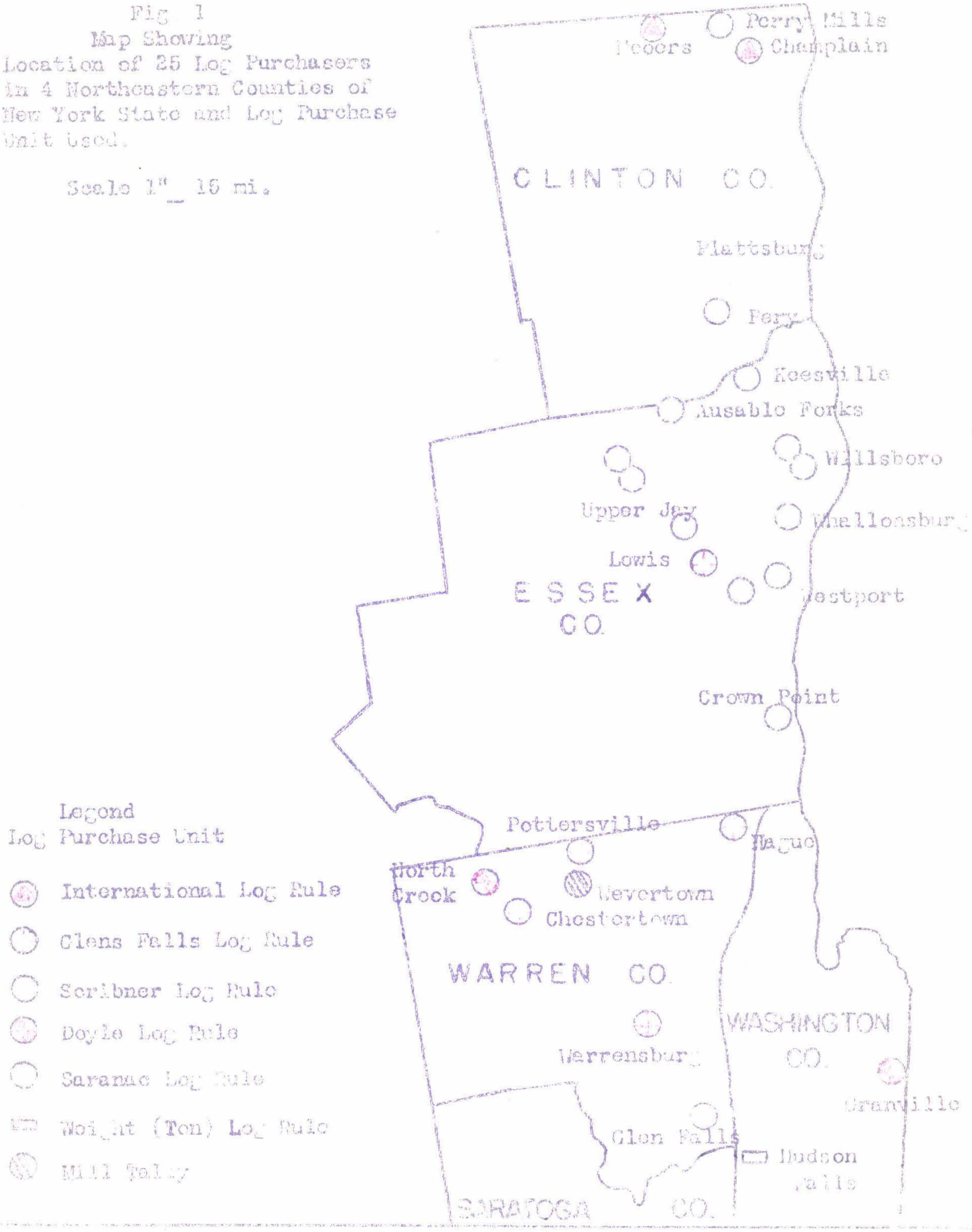
Fig. 1
Map Showing
Location of 25 Log Purchasers
in 4 Northeastern Counties of
New York State and Log Purchase
Unit used.

Scale 1"_ 15 mi.


CLINTON CO.
Mooers
Perry Mills
Champlain
Plattsburg
Peru
Keeseville
Ausable Forks
Willsboro
Upper Jay
Whallonsburg
Lewis
ESSEX CO.
Westport
Crown Point
Pottersville
Hague
North Creek
Wevertown
Chestertown
WARREN CO.
Warrensburg
WASHINGTON CO.
Granville
Glen Falls
Hudson Falls
SARATOGA CO.
Legend
Log Purchase Unit
International Log Rule
Glens Falls Log Rule
Scribner Log Rule
Doyle Log Rule
Saranac Log Rule
Weight (Ton) Log Rule
Mill Tally

Of the seven measures of log volume used, five are standard log rules; one is by the tally of lumber sawed; and the other is by weight. Table 1 shows the frequency of use of each of these units.

Table 1. Frequency of use of log purchase units in northeastern New York

	Operators no.	Volume purchased annually MM bd. ft.	Percent
Scribner Log Rule	7	7.2	51
Glens Falls Log Rule	6	2.3	16
Saranac Log Rule	6	2.0	14
Doyle Log Rule	2	1.6	11
International Log Rule	2	.5	4
Weight	1	.6	4
Mill tally	1	1/	2/
Totals	25	14.2	100

1/ Only 15 M bd. ft.
2/ Less than 0.5 percent.

The various units are used indiscriminately as to species except for the Doyle Rule, which is used for hardwoods only. There appears to be no correlation between rule used and products to be manufactured. The three most commonly used measures are the Scribner, Glens Falls, and Saranac Log Rules. Over half of all the timber sold annually is measured by the Scribner Log Rule, and it is believed this rule is gaining in popularity. The use of the Saranac Rule is pretty well confined to northeastern Essex County and of the Glens Falls Rule to Warren County. (See Figure I.)

In order properly to analyze and evaluate the price situation, it was necessary to bring the price paid by each buyer to a common base. This was accomplished by using a standard log technique. Differences in value resulting from variation in a lack of log-grading system in the cases studied were "ironed out" by arbitrarily selecting as a standard, a log 12" in diameter at the small end and 16' long. For white pine, hemlock, and hard maple a standard log meeting the specifications of the New England Timber Salvage Administration log-grading rules for a No. 2 log was used. In the cases of white ash and red oak, specifications for the No. 1 grade were used because purchases of these species in the region under consideration are confined chiefly to the better grades. The International 1/4" Log Rule was chosen as a standard measure of volume because the New England Timber Salvage Administration experience indicated that it was satisfactory for timber of similar size and quality.

The prices per unit paid by buyers for such standard logs were determined from the field data and then converted into prices per M, International 1/4" rule. The results are shown in the appended tables.

It will be noted that the comparative prices paid for white pine and hemlock by the several buyers, when brought to a common base, are mostly within a $3.00 range. Where the variation is greater, special circumstances are involved. For example, the highest price in white pine is paid by a small operator who runs a small mill work establishment and sells some finished material locally. Another buyer paying high prices is located near the man mentioned above. He also uses a small amount only and undoubtedly his price is governed by that of the first operator.

In the case of hardwoods there is much greater variation in the actual price per M than is the case in softwoods. This is due in part to the greater variation in type and value of products into which hardwood logs are put. For example, handle and ski manufacturers can pay a very high price for their raw material. The majority of the buyers in the region involved, however, are primarily in the softwood business, and handle hardwood only under special circumstances. This undoubtedly accounts for some of the great lack of uniformity in pricing of hardwoods.

Probably the most interesting purchase unit is that of weight. This is used by one firm and appears to result in generally lower prices than those paid under more conventional units. A difficulty in making price comparison, however, arises from the grade factor. This mill probably purchases a wider range of grades under the weight system than do the other buyers. Furthermore, the lower price undoubtedly compensates for included defective material which cannot be measured out.

Since this analysis indicates that prices paid under the several purchasing systems are fairly uniform, it is reasonable to suggest that a single unit be adopted as standard by all operators. It is evident that adoption of any one of the rules now used would work little hardship on any of the purchasers or timberland owners. Uniformity of practice would relieve timberland owners of the mathematical problem of comparing prices offered by different purchases and would doubtless lead to greater satisfaction all around.

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Table 2. Comparative prices for White Pine logs, No. 2 grade, 12" DIB small end, 16' long

Purchaser no.	Purchase unit		Price per M bd.ft. International Scale
	Name	Price	
1	International	$15.00	$15.00
2	"	18.00	18.00
3	Glens Falls	3.00	14.50
4	" "	2.25	10.80
5	" "	2.25	10.80
6	" "	2.50	12.20
7	" "	2.50	12.20
8	" "	2.50	12.20
9	Scribner	15.50	12.90
10	"	15.00	12.50
11	"	15.00	12.50
12	"	18.00	15.00
13	"	16.00	13.30
14	"	16.00	13.30
15	Saranac	3.00	11.50
16	"	3.00	11.50
17	"	3.00	11.50
18	"	3.00	11.50
19	"	3.00	11.50
20	"	3.00	11.50
21	Mill tally	12.25	12.25
22	Weight - ton	2.50	7.60

Table 3. Comparative prices for Hemlock, No. 2 grade, 12" DIB small end, 16' long

Purchaser no.	Purchase unit		Price per M bd.ft. International Scale
	Name	Price	
1	International	$15.00	$15.00
2	Scribner	13.75	11.50
3	"	15.00	12.50
4	"	18.00	15.00
5	"	16.00	13.30
6	"	15.00	12.50
7	Glens Falls	3.00	14.40
8	" "	2.25	10.80
9	" "	2.25	10.80
10	" "	2.25	10.80
11	" "	2.50	12.00
12	" "	2.50	12.00
13	Saranac	3.00	11.55
14	"	3.00	11.55
15	Weight - ton	2.50	9.40

Table 4. Comparative prices for Hard Maple logs, No. 2 grade 12" DIB small end, 16' long

Purchaser no.	Purchase unit		Price per M bd.ft. International Scale
	Name	Price	
1	International	$16.15	$16.15
2	"	18.20	18.20
3	Scribner	20.00	16.60
4	"	20.00	16.60
5	Doyle	15.00	10.10
6	Glens Falls	3.50	16.80
7	" "	2.50	12.00
8	" "	3.00	14.45
9	" "	2.50	12.00
10	Saranac	4.00	15.40
11	Weight - ton	2.50	10.85

Table 5. Comparative prices for Red Oak logs, No. 1 grade 12" DIB small end, 16' long

Purchaser no.	Purchase unit		Price per M bd.ft. International Scale
	Name	Price	
1	Scribner	$22.00	$18.30
2	"	24.00	20.00
3	Glens Falls	2.50	12.00
4	" "	3.00	14.40
5	" "	3.50	16.80
6	" "	2.50	12.00
7	Saranac	4.00	15.40
8	Weight - ton	2.50	12.45

Table 6. Comparative prices for White Ash logs, No. 1 grade, 12" DIB small end, 16' long

Purchaser no.	Purchase unit		Price per M bd.ft. International Scale
	Name	Price	
1	International	$28.00	$28.00
2	"	18.00	18.00
3	Scribner	22.00	18.00
4	"	24.00	20.00
5	Doyle	15.00	10.10
6	"	50.00	33.70
7	Glens Falls	3.50	16.85
8	" "	2.50	12.00
9	" "	3.00	14.40
10	" "	2.50	12.00
11	Saranac	4.00	15.40
12	Weight - ton	2.50	9.35

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Technical Note No. 45 November 25, 1941

UNITED STATES DEPARTMENT OF AGRICULTURE
Northeastern Forest Experiment Station [1]

COLLECT THE BOUNTY ON YOUR WOLF-TREES 2.24

by

G. R. Condit, Agricultural Aide
M. A. Huberman, Associate Silviculturist
John R. McGuire, Agricultural Aide

In any society where a few individuals take more than their proper share of lebensraum, resources, and other good things of nature, thus endangering the welfare of the community, steps must be taken to curb the unreasonable demands of such "wolves". So also in a woodlot, the farmer may find undesirable trees which occupy too much space, crowding out young trees, or at least retarding their growth rate. Worst of all, these "wolf-trees" are so crooked and grotesquely shaped that there seems to be hardly a merchantable log in them. These trees behave in every way as "wolves" in the woodlot community. If there were a bounty offered to get rid of these "wolves" every farmer could improve his woodlot and make more room for fast-growing straight young trees.

At the present time the strong demand for wooden containers in the defense program provides the opportunity for collecting just the bounty needed in the white pine region of the Northeast. A study was therefore made at the Massabesic Experimental Forest in southwestern Maine to find out how serious a problem wolf-trees are in taking up useful space, in holding back good log-producing young trees, and in keeping down seedlings; to determine the cost of removing such wolf-trees, and to see what cordage in fuelwood and how many board feet in box-board logs can be obtained from them. In short, is the bounty on these wolf-trees enough to make it worth while for a farmer to collect it?

The results of the study are as follows:

1. Space occupied.--In some cases there may be more than six wolf-trees to the acre having an average crown spread of 800-900 square feet and occupying as much as 13 percent of the area.

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2.--Effect on reproduction establishment.--Although wolf-trees permit some reproduction to catch hold under their crowns, the number of young trees which would normally fill such space is markedly reduced.

3.--Effect on growth rate.--White pines which attain sapling size under wolf-tree crowns grow much more slowly in diameter and height than do those away from the wolf-trees. Full development of young trees to merchantable size is impossible in the area occupied by wolf-tree crowns.

4.--Costs and returns.--The returns from 15 wolf-trees cut and made into logs and cordwood indicate the opportunity presented now by a strong market for boxboard logs and fuelwood. Logs brought $7.00 per thousand, fuelwood $1.50 per cord; and labor was $0.40 per hour. Seven trees from which logs and fuelwood were made brought a profit ranging from $0.56 to $1.53 per tree, over and above labor costs. Three trees from which only fuelwood could be made were cut at a loss of from $0.19 to $1.37. Five trees from which only logs were made brought a profit of $0.54 to $1.79 per tree. The trees from which logs can be produced can be operated at sufficient profit to pay for wolf-trees which yield only fuelwood at the rate of about two or three log-trees for one non-log tree. Where the woodlot owner is in a position to do his own work, without any outlay of cash, returns are still more attractive and there is no question as to the profit in cutting wolf-trees.

5. Damage to reproduction in felling.--The number of seedlings and saplings destroyed is usually not over one-fourth to one-third of the total stand involved; and whereas girdling undoubtedly causes less damage, the absence of any immediate cash return tends to discourage the adoption of the practice.

Recommendation

On the basis of this study it is recommended that farmers in the Northeast take advantage of the present market condition to improve their white pine woodlots by cutting out wolf-trees now. Should labor for cutting and skidding be lacking, benefits from woodlot improvement without any cash return, may still be obtained by girdling the most undesirable wolf-trees.

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Technical Note No. 46 December 22, 1941

UNITED STATES DEPARTMENT OF AGRICULTURE
Northeastern Forest Experiment Station[1]

EFFECTS OF INDOLEBUTYRIC, INDOLEACETIC, AND NAPHTHALENEACETIC ACIDS ON ROOTING OF RED MAPLE CUTTINGS

1.3143

by

Albert G. Snow, Jr.
Assistant Plant Physiologist

The vegetative propagation of forest-tree species by means of cuttings is facilitated greatly by the use of growth-substances. It has been shown that the rooting of cuttings of species such as trembling aspen and sugar maple will not take place to any appreciable extent without chemical treatment. To insure rooting of such species as red maple and white pine a combination of controlled environmental conditions, such as temperature, moisture, and type of rooting medium, and the proper treatment with growth-substances is required. The experiments reported in this note illustrate that in red maple there is a differential response with the actual chemical used in both percentage rooting and type of roots produced.

Replicate groups of red maple cuttings (20 per group) collected June 25, 1941, were treated for 3 hours with the three growth-substances indolebutyric, indoleacetic, and naphthaleneacetic acids at concentrations of 100, 200, and 400 milligrams per liter. After two months in outdoor propagating beds the cuttings were examined for percent rooting and types of roots produced. The percent rooting under the several treatments appear in Table I.

Table I

Percent Rooting of Greenwood Cuttings of Red Maple

Treated with Three Growth-substances

Concentration (mg./l.)	Average percent rooting		
	Indolebutyric	Indoleacetic	Naphthaleneacetic
100	85.0	55.0	62.5
200	87.5	65.7	62.5
400	70.0	78.4	75.7

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Indolebutyric acid. Consistently higher rooting percentages were obtained with all but the strongest concentrations of this acid, and the types of roots were much superior in number, length, and extent of branching. The results of this, and particularly of other experiments,[2] show that a concentration of 200 mg./l. is about optimum.

Indoleacetic acid. Treatments with this chemical resulted in a low percent rooting (except at a concentration of 400 mg./l.) and the poorest types of roots of the three growth-substances used. Although 78.4 percent rooted at a concentration of 400 mg./l., the few short roots lacking adequate branching were typical of all cuttings treated with indoleacetic acid.

Naphthaleneacetic acid. At the highest concentration used (400 mg./l.) this chemical was nearly as efficacious as indolebutyric acid, with numerous long and well branched roots occurring on 75.7 percent of the cuttings. A smaller number rooted at the lower concentrations with the roots long and well branched, though fewer in number.

In general, indolebutyric acid appears to be the best of the three growth-substances to use on greenwood cuttings of red maple, although naphthaleneacetic acid was nearly as good. It is possible that higher concentrations of the latter chemical would produce results equal to that of indolebutyric acid. Indoleacetic acid is decidedly inferior to either of the other chemicals for red maple.

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[2] Snow, Albert G., Jr. Variables affecting vegetative propagation of red and sugar maple. Jour. For., 39(4):395-404. 1941.

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Technical Note No. 47 December 15, 1941

UNITED STATES DEPARTMENT OF AGRICULTURE
Northeastern Forest Experiment Station 1/

FRUITING OF 10-YEAR OLD CONIFERS

1.3144

by

L. H. Reineke

In the course of the 1941 spring remeasurement of some young plantations of white spruce, red pine, and white pine, the presence of a rather large number of cones was noted. These trees were set in the field as 2-0 stock in the spring of 1933, making the season of 1940 the 10th growing season. The white spruce and white pine had matured a crop of cones during 1940, while both white and red pines bore cones which will mature in 1941.

In addition to their precocity, these cone-producing trees are interesting because of the relation of tree size to proportion of trees fruiting and to number of fruits per tree. As shown by the table, no spruce or red pine less than 3.0 feet, or white pine less than 4.0 feet tall bore cones. Of the 3.0-3.9 foot class of white spruce, only 3.8 percent of the trees bore cones (Col. 4), this proportion increasing to 40.0 percent in the 5.0-5.9 foot class, and 66.7 percent in the tallest (7.0-7.9 feet) class. The average number of cones per fruiting tree (Col. 5) increased from 2.8 for the smallest to 6.7 for the 5 foot class, and 26.5 for the tallest class.

Similarly, the percentage of red pines bearing cones (Col. 8) increased from 1.3 percent for the 3.0-3.9 foot class to 44.7 percent for the 6.0-6.9 foot class, and 71.5 percent in the 8.0-8.9 foot class. The 100 percent value for the tallest class represents one tree only and of itself is not significant. The increase in number of cones per tree (Col. 9) from 1.3 to 2.6 to 4.0 for the height classes above is not as rapid as for white spruce, yet is quite definite.

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White pine was the one species fruiting in two successive years. Of the 24 white pines which matured cones in 1940, only four developed cones maturing in 1941, while 14 trees barren in 1940 will mature some cones in 1941. The white pine trends in cone production are the least well-defined, although a trend in the proportion of fruiting trees is indicated roughly (Col.15) by increases from 1.6 percent and 1.1 percent in the 4 and 5 foot classes to 9.0 percent in the 6 foot class, and 15.7, 14.7, and 12.5 percent in the 7, 8, and 9 foot classes. The number of cones per tree has no definite trend, averaging 2.6 cones of 1940 maturity and 3.5 cones of 1941 maturity. Trends may have been obscured by the fall of some 1940 cones from the trees before the examination, since some fruiting trees may have lost their cones and thus be recorded as not fruiting, and the count of cones remaining on the tree would not give true total production. The attack by weevils in 1939 and 1940, with control by clipping of leaders, is another disturbing factor in the white pine data. Loss of cones or prevention of development of new cones would affect most the results for taller trees, since weevil attacks are more prevalent on such trees.

It should be recognized that these cone-production figures indicate only partially the extent of blossoming. Under the most favorable conditions probably only half the female flowers will set fruit, and these plantations were not favored by the near presence of mature, prolific pollen producers.

From the genetics viewpoint, early fruiting and the production of even a few viable seeds are of great importance for curtailment of the time interval between successive generations. The close association of number of fruits, and percentage of trees fruiting, with height of tree may be connected with inherent vigor characteristics, but it suggests that favorable growing conditions may induce earlier fruiting of breeding stock.

The discovery of trees with inherent early fruiting habits offers possibilities for the development of tree seed orchards for commercial production of seed of desirable tree strains. Trees of early fruiting habits, and particularly those of repeated fruiting, would bring such orchards into production at an earlier date with tree sizes more favorable for seed collection.

Early and frequent seeders also would be of value for the reclamation of extensive areas, where the bulk of the forest would be established by seeding from skeleton plantings of early seeders.

RELATION OF FRUITING TO TOTAL HEIGHT

Total height	White spruce				Red pine				Eastern white pine							
	No. of trees			Cones per fruiting tree	No. of trees			Cones per fruiting tree	No. of trees						Cones per fruiting tree	
	Examined	With fruit matured in 1940			Examined	With fruit matured in 1941			Examined	With fruit matured in						
										1940 only	1941 only	1940 and 1941	Total			
ft.		No.	Per-cent			No.	Per-cent						No.	Per-cent	1940	1941
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
0- 0.9	8	0	0	-	7	0	0	-	5	0	0	0	0	0	-	-
1.0- 1.9	55	0	0	-	26	0	0	-	35	0	0	0	0	0	-	-
2.0- 2.9	92	0	0	-	117	0	0	-	94	0	0	0	0	0	-	-
3.0- 3.9	105	4	3.8	2.8	223	3	1.3	1.3	142	0	0	0	0	0	-	-
4.0- 4.9	67	3	4.5	9.0	296	26	8.8	1.3	191	3	0	0	3	1.6	3.3	-
5.0- 5.9	25	10	40.0	6.7	201	52	25.8	1.8	176	2	0	0	2	1.1	1.5	-
6.0- 6.9	11	4	36.4	13.5	114	51	44.7	2.6	122	8	2	1	11	9.0	2.9	2.0
7.0- 7.9	3	2	66.7	26.5	40	27	67.5	2.6	89	4	8	2	14	15.7	2.3	3.5
8.0- 8.9					14	10	71.5	4.0	34	2	2	1	5	14.7	2.3	6.0
9.0- 9.9					1	1	100.0	5.0	16	1	1	0	2	12.5	2.0	1.0
10.0-10.9									3	0	0	0	0	0	-	-
11.0-11.9									1	0	0	0	0	0	-	-
12.0-12.9									1	0	1	0	1	100.0	-	3.0

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Technical Note No. 48 January 1, 1942

UNITED STATES DEPARTMENT OF AGRICULTURE
Northeastern Forest Experiment Station 1/

SPECIFICATIONS AND INSTRUCTIONS FOR USE OF THE SPRAY GUN FOR MARKING TIMBER

2.3

by

D. E. Rulison
Junior Forester

The use of the spring spray gun as a tree-marking instrument was first described by J. B. Folsom in the March 1937 issue of the Journal of Forestry. Since that time, its use as a practical marking tool has attracted enough interest to merit the reiteration of specifications of the gun and directions for its use.

Specifications: Five years' experience marking timber in the Cooperstown, New York Forest Unit, has shown that a gun with specifications equal to those of the Alemite Spring Spray Gun - Model 6121, equipped with the solid oil stream nozzle, manufactured by the Stewart-Warner Corporation, Chicago, Illinois, works best. These cost $5.50 each. The following minor alterations are essential to satisfactory operation.

1. Remove the nozzle cleaner.
2. Ream out the nozzle to about .04 inches.
3. Remove the wire strainer from the intake valve.
4. Pack the opening beneath the trigger with hard grease (S.A.E. 90).

Paint Mixture: Red oxide barn paint mixed with an equal part of kerosene is cheap and has proven entirely satisfactory. With kerosene at 13¢ per gallon and paint at $1.40 per gallon, the cost of a fifty-fifty mixture is 77¢ per gallon, or 19¢ per quart. One quart of mixture will make 200 spots.

Care in preparing the mixture for use is most important for efficient operation. The paint and kerosene should be mixed thoroughly and then strained to remove all particles which can plug the gun nozzle.

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A piece of window screening, pressed into the mouth of the funnel used in filling the field containers, is a satisfactory strainer.

Field Containers: One gallon glass jugs are the best field containers. It is easy to pour from them into the paint gun container; they are convenient size and their low cost (10¢) makes replacement inexpensive if, and when, accumulation of sediment lowers their capacity appreciably.

Cleaning: Successful and dependable operation of gun demands current cleanliness. The simplest way to insure this is to empty the gun and containers of paint immediately after the day's work, partially fill with kerosene, shake up vigorously, and then squirt the gun until the paint in the nozzle has been replaced by kerosene. The kerosene should be left in the guns until they are used again.

Other Uses: The spray gun can be used to make a number of different types of marks and, hence, can be used for several purposes very handily. In the work at Cooperstown, a standard system of spotting has been worked out. This is as follows:

1. One spot indicates a tree suitable for fuelwood only.
2. Two spots indicate a tree with industrial products in it.
3. A vertical line indicates a tree to be pruned.
4. A horizontal line indicates a tree to be girdled.
5. Three parallel or oblique lines indicate a boundary line.

Where trees are to be removed, the stumps are usually given a spot to aid in checking the cutting.

The gun has also been found useful in checking inventories of logs and lumber. In a lumber yard, for example, where piles are incomplete at the time of inventory, a spot of paint can be easily placed on the top course, no matter how high in the air it may be. The future inventory can be taken by counting the courses beyond the spot. The gun has been useful where logs are coming to a common skidway from two separate lots. The logs from one lot can be marked prior to skidding very readily.

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Technical Note No. 49 February 6, 1942

UNITED STATES DEPARTMENT OF AGRICULTURE
Northeastern Forest Experiment Station [1]

BALSAM FIR -- USE IT, DON'T LOSE IT

2.2

Perley Spaulding, Senior Pathologist — Bureau of Plant Industry [2]
Marinus Westveld, Senior Silviculturist — Northeastern Forest Experiment Station [1]
J. R. Hansbrough, Associate Pathologist — Bureau of Plant Industry [2]

Results of investigations on the silviculture and pathology of balsam fir in the Northeast show plainly that this short-lived tree should be managed on a shorter rotation than the much longer-lived red spruce. Since red spruce has long been considered the most important species economically in the mixed spruce-fir forests of the Northeast it is not surprising that the silvicultural handling and harvesting of these stands has been aimed solely at red spruce with little regard for balsam fir requirements. But the situation has changed; balsam fir has increased in relative value, and moreover, is increasing numerically in the northern coniferous forests. It appears inevitable that the future forests of the spruce region will contain a greatly increased proportion of balsam fir. Observations on extensive cutover areas show that whereas in the preceding stand spruce predominated over balsam fir, in the young stands the situation is reversed. Approximately 60 percent of the present sapling growth on areas studied recently in the Adirondacks, consists of balsam fir in contrast to only 37 percent of the preceding stand. The evidence is clear that future cutting policies must take into consideration the increased representation and importance of balsam fir in the economy of the spruce-fir forests of the Northeast.

The present relatively low yield of these forests cannot be attributed entirely to low productivity, but rather is caused by failure to harvest much of the usable growth of balsam fir. Basically, this is the result of failure to adapt operating methods and cutting systems to the natural rotation of balsam fir. The clear cutting system practiced in this region removes practically all spruce and fir above 6 inches d.b.h. leaving a residual stand of unmerchantable-sized conifers which often is dominated by overmature hardwoods. Thirty-five to 60 or more years often must elapse before the new growth is deemed to be sufficient in volume to justify another cut. This period is long enough to permit considerable numbers of the shorter-lived and faster growing balsam firs to reach maturity and succumb to windfall or to become highly defective with decay. Red spruce, being long-lived and resistant to decay goes through such long cutting cycles with but minor losses.

Owners of spruce-fir lands can ill afford to ignore the heavy losses in balsam fir sustained when operating on long cutting cycles. Wood products of all kinds, particularly paper and other wood fibre products are becoming increasingly important in the exigencies of a war economy. In the effort to provide adequate supplies of these products there is great danger

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[2] In cooperation with the Northeastern Forest Experiment Station.

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that the clear cutting system which is basically unsuited to the broad objectives of maintaining maximum production in spruce-fir stands, will proceed at a greatly accelerated pace. Reason points to partial cutting as the logical answer to the problem. With motor transport it is possible to harvest profitably a smaller crop per acre than was formerly the case. This system, which removes slow growing, defective, and inferior trees by repeated light cuts at intervals of 10 to 20 years promises high yields not only through increased growth but also through utilization of a larger proportion of the balsam fir pulpwood grown. Such a cutting policy will further simultaneously the interests of both the spruce-fir timber land owners and the long term defense program for our country.

Balsam fir, from early life to maturity is subject to several types of decay. Butt rot is especially important in balsam fir because it weakens affected trees near the ground and makes them liable to wind breakage. Butt rot begins at about 40 years and increases rapidly until at 70 to 80 years it is present in the majority of the trees. Windfall, largely induced by butt rot, destroys large numbers of these affected trees at 70 to 80 years, usually causing complete loss of the fallen trees because of failure to harvest at this critical time. Trunk rot, or red heart rot, begins also at about 40 years but increases more slowly than does butt rot. Hence butt rot becomes the limiting factor among the rots in setting the cutting age for balsam fir. It is concluded that the increase of wind breakage after 70 years makes it imperative to use this as the maximum felling age for this species. Cutting at 70 years of age in unmanaged stands means that the trees will have an average diameter of not more than 8 or 9 inches. Most unmanaged stands, however, have endured severe suppression some time in their life span and the average size of the trees is much smaller than will be the case in stands maintained in thrifty condition.

Since cull from decay is not appreciable until 50 years of age, and since losses from decay and windfall become critical at 70 years, the difference between these ages, 20 years, should be the maximum time between cuttings for the best utilization of balsam fir.

It has been shown that balsam fir is able to survive periods of severe suppression and to resume satisfactory growth when freed from overtopping trees. But it was noted by Zon 30 years ago, and now is confirmed, that such severe suppression favors infection by trunk rot (red heart), much of which could be avoided by maintaining a uniformly thrifty growth. Such thrifty growth can be maintained by properly timed weeding in over-dense reproduction, thinning in sapling stands, and girdling of overtopping hardwoods.

Partial cutting of spruce-fir stands at intervals of not more than 20 years, removing balsam fir at 50 to 70 years of age, and spruce on a selection basis, coupled with cultural treatment to maintain a thrifty growth of properly spaced crop trees, will not only reduce the loss from rot and windfall, but also will greatly increase the average diameter which balsam fir will attain before reaching the age at which cull and windfall becomes critical. The writers believe that under the above system of forest management the average yields per acre from spruce-fir lands may well be doubled.

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Technical Note No. 50 February 7, 1942

UNITED STATES DEPARTMENT OF AGRICULTURE
Northeastern Forest Experiment Station [1]

FUELWOOD SEASONING TESTS

4.14

By

Allen W. Bratton, Assistant Forester

Before long the New England farmer and woodland owner will demand the grading of cordwood and logs from his woodlot just as he grades his apples and his eggs. Some buyers specify certain lengths, diameter limits of sticks, and often sawed ends, -- such requirements being largely for ease in handling and measurement, or to improve appearance. Sale of cordwood on a graded basis will be more popular when it is realized that both seller and buyer benefit. Price would be determined on the basis of such factors as percentage of species, size of sticks, whether round or split, location of pile, and length of time in pile.

Wood is usually considered to be well seasoned when its moisture content is below 25 percent but this may require more than the usual year in the pile unless factors affecting seasoning are given full consideration. A cord of hardwood may lose from 800 to 1500 pounds in seasoning, depending somewhat on species, and a year's seasoning resulting in a moisture content of 40% instead of the desired 25 percent means an increased hauling weight of 300 to 500 pounds per cord with consequent increased transportation costs and a poor burning product.

Recent tests on red oak fuelwood show that during seasoning the moisture content does not vary through the length of the stick, except within an inch or two of the ends, where it is usually 20 to 30 percent less. Length therefore is of little importance in seasoning ordinary cordwood; a stick 8 feet long dries just about as fast as if cut into two 4-foot lengths. Diameter, however, makes a big difference, the smaller diameters of 4, 5 and 6 inches drying from the usual 70% greenwood moisture content down to 50% in 6 months as compared to a reduction to only 65% for the 8 and 10-inch diameter sticks.[2] Splitting increases the rate of drying, once-split sticks averaging 10 to 15 percent less moisture than round sticks after 6 months seasoning. In other words, the 10-inch sticks would have dried as fast as the 5-inch sticks had they been split.

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[2] For the Red Oak tested, considered rather slow drying.

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Other things being equal (location of pile, species, etc.) drying is to a large extent dependent upon surface area exposed. The table below shows the ratio of solid cubic foot volume to surface area exposed for cords of different diameters, split and unsplit.

RELATIONSHIP OF SOLID CUBIC VOLUME TO SURFACE AREA EXPOSED

Middle Diameter Outside Bark	Number of sticks in standard cord	Ratio of volume to surface area exposed		
		Round	Split once	Quartered
5	93	1:10	1:16	
6	75	1:8	1:14	
7	61	1:7	1:12	
8	50	1:6	1:10	
9	42	1:6	1:9	
10	35	1:5	1:8	
11	30	1:5	1:8	
12	26	1:4	1:7	1:10

Thus to insure uniform rapid seasoning, sticks above 8" should be split once and those above 12" twice.

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UNITED STATES DEPARTMENT OF AGRICULTURE
Northeastern Forest Experiment Station 1/

LOGGING DAMAGE IN PARTIAL CUTTING OF SPRUCE-FIR STANDS 2.2

by

G. R. Trimble, Junior Forester

Although observations indicate that harvesting of spruce-fir stands under a partial cutting system results in damage to the residual stand, little factual data regarding its seriousness are available in the literature. Culmination of a timber sale in second growth spruce-fir stands on the Gale River Experimental Forest calling for selection cutting, provided an opportunity to obtain detailed data on the character and extent of this damage. Since skillful partial cutting in spruce-fir stands aims to retain a desirable distribution of size classes in the residual growing stock, it is important to the forest manager to know which class of trees is most likely to be damaged or destroyed. This knowledge enables the timberland owner interested in retaining a specific amount of growing stock on his lands to so execute his marking as to compensate for the expected logging losses.

Logging damage data were obtained from 32 plots which had been established on the cutting area primarily for growth study purposes. Three types of stands were represented, some predominantly fir, others predominantly spruce and the remainder hardwoods in mixture with spruce and fir. The one horse method of logging was employed, single tree hitches being used exclusively. Since cutting and skidding were undertaken largely during the peeling season when bark slips easily damage to tree bases was probably greater than would have occurred had twitching been done when the bark was firm.

Damage was classified as to origin. In decreasing frequency they were (1) skidding, (2) felling, and (3) axe injury. Damaged trees were divided into two condition classes (1) trees promising to recover with little or no reduction in value, and (2) trees not likely to recover, including those destroyed in logging and those so badly damaged as to be of doubtful future value. Hardwoods were ignored.

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The important fact brought out by this study is the small amount of serious logging damage sustained in partial cutting operations under the system of logging used. Highest losses occurred in the predominantly fir stands where 3.9 percent of the spruce-fir residual growing stock was destroyed followed by the mixed spruce-hardwood and predominantly spruce stands with losses of 1.9 percent and 1.3 percent, respectively. The additional logging damage, however, in the form of injured trees which hold definite promise of early recover, amounts to 13.7 percent, 6.6 percent, and 3.2 percent respectively.

The study also revealed that fir is more easily injured than spruce. This fact is attributed largely to the brittle character of fir wood and the greater ease with which fir peels than spruce. The quantity of residual fir growing stock destroyed in logging amounts to 3.3 percent as against only 1.1 percent for spruce, while the recoverable damage amounts to 9.2 percent and 5.2 percent respectively.

Analysis of the data shows that an increase in the average diameter of the residual stand is accompanied by an increase in the amount of growing stock damaged; also there are indications that the greater the amount of residual growing stock the lower is the percentage damaged. Usually the average diameter of the injured and destroyed trees is less than that of the residual stand. This may be due to the ease and resulting frequency with which loggers cut small trees to facilitate skidding and felling.

The study indicates clearly that logging damage in second growth spruce-fir pulpwood stands is no deterrent to partial cutting when carried out with horse logging. It appears that the forest manager by increasing the residual volume of growing stock of fir by 3 to 10 percent and spruce by 1 to 5 percent, depending on such factors as the composition of the stand and its average diameter, can readily make adjustments for the amount destroyed in logging. The greater risk of logging damage to fir combined with its lower intrinsic value points to the desirability of marking fir more heavily than spruce in order to avoid losses of fir and increase the proportion of spruce in the residual stand.

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UNITED STATES DEPARTMENT OF AGRICULTURE
Northeastern Forest Experiment Station [1]

VIEW-POINTS ON FARM FORESTRY

7.5

A radio talk given at Ithaca, N. Y., February 12, 1942

by

C. R. Lockard, Forest Economist

Of all the nation's forest lands, the farm woodlands offer the best opportunity for intensive forestry. These are accessible and close to markets. They are closely associated with people who generally are in need of the addition to income which forest management can bring. Woodland on farms is an essential part of our national timber supply; comprising one-third of the nation's commercial forest area. It is a fact, however, that in spite of their inherent advantage, farm forests are not managed with the same degree of care and foresight generally applied by farmers to the remainder of their farms. There is plenty of information on how to manage farm forests, but somehow it does not take hold. Why?

There are a number of obvious obstacles to the practice of farm forestry. Any farmer will tell you that bad woodlot management, or lack of management, is due to such things as need for cash, which implies a lack of credit facilities; to old age, which is another way of saying, uncertainty of tenure; or to lack of adequate markets. These obstacles are real, but they can be overcome.

There is an idea that, if these obstacles are eliminated, adequate attention will be given to farm woodland management. Is this idea sound? Investigations indicate that it is not. The situation seems to be similar to that in the story of the experiment carried on by heating engineers. Theories concerning conduction of heat were set up and tested. The results did not come out as expected and the first reaction was to consider the theory unsound. However, further investigation brought out the fact that a thin coating of air adhered to the metal surface of the heater and threw the results off. Eliminating this air brought theory and practice into line. Are forest management theories unsound? Or is there a "thin coating" which prevents being translated into practice. We are convinced that it is the latter, a "thin coating" of what may be termed "view-point", which is holding farmers back.

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Within wide limits, human actions are governed by view-points. A man looks upon a chicken as a dinner; a chicken looks upon man as nemesis. The result is that man runs toward the chicken and the chicken runs away from man. There are quite divergent view-points held by various people in regard to the woods. Sometimes, and this is vital, there is no view-point at all. Or if there is a feeling, it entered into the intellectual background of the farmer at such an early date that it may not be considered as a view-point. For example, the most recent Census of Agriculture does not even list wood as a farm crop. Histories of agriculture do not give timber as one of the nation's heritages. The agricultural historian seems to say that all farm progress hinged on developing additional areas of arable land. Foresters looking at the situation say "clearing land for agricultural purposes has caused the destruction of more forest area than any other agency".

A positive view-point is that forests, unless producing logs or other high grade products, are not particularly valuable. If a forest produces nothing but fuelwood, its value may be under-estimated because the wood is fit only to be burned. However, according to modern agricultural economic thought, fuelwood burned is worth what it can be bought for. This means that every face cord of wood cut and burned is worth at least $3.50 to the farmer. If wood were not available and the farmer today had to buy a substitute such as coal or oil, it would be worth from thirty to one hundred percent more.

Another view-point is that wood should be valued only on the stump. Other products of the farm are generally valued at the market. Oats, for example, are worth $0.39 per bushel according to the Census. Cultivating, harvesting and hauling costs bring the value "on the stalk" back to $0.21 a bushel, or sixty percent of the delivered value. Similarly, one hundred pounds of milk delivered at $2.00, is worth $1.25, or sixty-four percent "in the cow". Timber value "on the stump" is about fifty percent of market value. Thus, when other farm products are valued at the source, timber by comparison is not such an "ugly duckling".

Another view-point, frequently expressed, is that working in the woods is a very low paid occupation. Other farm crops, according to Cornell Extension Bulletin 439, give a labor return of from minum eleven to plus sixty-eight cents per hour. It is commonly said that a dairy farmer makes a dollar a day. There is very little work in the woods which will not pay more than this. Cutting and skidding logs, cutting cordwood, fence posts, Christmas trees, pulpwood and other forest products will give from forty to sixty cents an hour to a competent workman, a favorable return in comparison with other farm crops.

Another view-point is that forest lands are low producers compared to other crop lands. Certain specialized crops do produce high yields. At the present market, the net dollar yield of oats, however, is minus $8.00 per acre per year. Based on a 5500 pound cow, using five and one-half acres of land for feed, the net return per acre from milk is minus $2.20. This is in line with the results shown in the Cornell Cost Accounts Bulletin which says that the "total cost of keeping a cow for a year, including not only the feed and labor, but depreciation on the animal, use of buildings, breeding fees, and so forth, has averaged $195.00, or $11 more than the value of the milk, manure, and calves." An average piece of timber land should produce about 150 bd. ft. a year and in addition two face cords of fuelwood. Actual production cost is cost of overhead. Applying group values to the production, and taking off cost, the producing value of an acre of woods is minus $1.75. Again, the woodlot does not compare unfavorably with other activities. In dealing with other farm products, it should be kept in mind that these latter have been subject to years of careful cultivation. In the woods, on the contrary, most of the operations have tended to pull down production possibilities.

Another view-point which we find, is that the forest and not wood is the crop. Modern forest techniques are based upon a continuous and not intermittent production once in several generations. On old forests, continuous cuts can be arranged at once, in new forests, the yearly harvest can start at not over 25 years of age. First cuttings will not be sawlogs, but studies in various parts of New York State have shown that other products such as fuelwood or fence posts are just as valuable as certain grades of sawlogs. Under such a program, the amount sold is equal to the growth. Wood, not the forest, is sold.

Another view-point is that the forest needs no care. We often hear "my grandfather cut it off, and today it is a good forest". This may be true, but the question is how much better the forest would be had proper cultural operations been applied. One dollar spent on pruning, for instance, will give a twenty dollar return in increased value of products. Studies of hardwood timber production in well formed stands, show at least 40 percent more value than in poorly formed stands. The possibilities of improving on nature are indicated by the difference between yields of modern crop plants as compared with those of the original "wild plant". The productive ability of "tame timber" will be surprising.

Another view-point is that forest practice is too specialized for the farmer. It is true that technical help is valuable in the woods just as it is in the dairy. Actually, dairying is a complicated business, but the farmer has a good working knowledge of technique and of economics. He should have the same knowledge of the woods. He should know good logs from poor logs and he should know which price to ask and which to accept. He should know the cost of and returns from handling trees of different sizes so that he will cut or sell only the proper trees. The other forms of farming are aided by both Federal and State organizations in both production and marketing, but for forest products, available marketing aid, in particular, is insufficient.

We believe it is factors such as these we have been discussing, which hold up the application of forest practice to the woods. Few farmers or farm leaders appear to consider the woodlot as an integral part of the farming business. In some cases this may be due to the fact that the farm woodlot, through past treatment, is in such poor condition that the income possibilities have been lowered to a point where several generations of time and a considerable amount of energy will be required to re-build. There is, however, still a large area of land in this State owned as part of operating farms which can be tied into the farm business in a very desirable way. The forest enterprise, properly handled, is a "natural" in a system which more and more depends upon integration for profitability. The present situation cannot be changed by legislation or by more liberal credit facilities alone; wood farmers will be made by the same process as milk farmers, or chicken farmers, -- by a process of "trade" education. Considerations such as those presented, will lead to a demand for such education.

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UNITED STATES DEPARTMENT OF AGRICULTURE
Northeastern Forest Experiment Station[1]

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NORTHEASTERN LUMBER PRODUCTION IN 1941

8.22

By
Victor S. Jensen and
Richard C. Desmond

Preliminary results of a census of the lumber industry in New England and New York conducted by the Northeastern Forest Experiment Station in cooperation with the Bureau of the Census, Department of Commerce, are given below. The sharp rise in production shown for 1941 as compared with 1940 is doubtless greater than the actual increase because the mail canvass of 1940 was amplified by field follow-up in certain states in 1941.

Production of lumber in Connecticut, Rhode Island, Massachusetts, and New Hampshire was obtained by mailed questionnaires supplemented by a field canvass which accounted for practically all sawmill operations. In Maine, Vermont, and New York it was not feasible to make a field canvass. Production of these states was estimated from the response to the first request for information sent out by mail. Inasmuch as the response to a first request by mail in the four states which were later covered intensively accounted consistently for about 40 percent of total production, this proportion was assumed to obtain for both softwood and hardwood production in Maine, Vermont, and New York. The preliminary estimates which appear here are, of course, subject to later correction.

Hardwood and Softwood Lumber Production
(Mills cutting more than 50 M bd.ft. annually)

State	Hardwood		Softwood		Total	
	1940 Census	1941 Estimate	1940 Census	1941 Estimate	1940 Census	1941 Estimate
	M ft.b.m.	M ft.b.m.	M ft.b.m.	M ft.b.m.	M ft.b.m.	M ft.b.m.
Conn.	10,439	9,962*	5,270	8,238*	15,709	18,200*
Maine	34,935	33,945	195,237	389,930	230,172	423,875
Mass.	8,494	12,040*	56,309	105,880*	64,803	117,920*
N. H.	22,515	32,545*	166,452	310,228*	188,967	342,773*
New York	69,562	122,435	40,314	77,192	109,876	199,627
R. I.	1,298	2,004*	5,712	7,790*	7,010	9,794*
Vermont	33,908	61,588	63,346	112,070	97,254	173,658
Total	181,151	274,519	532,640	1,011,328	713,791	1,285,847

*Return complete

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